This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

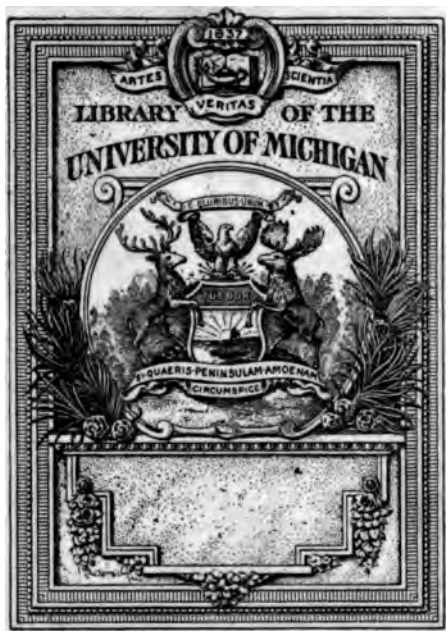
+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

B 1,073,583



THE GIFT OF
Wm. Breeders asso

QH
431
.A2
A512

AMERICAN BREEDERS' ASSOCIATION

VOLUME III

1907

Report of the Meeting Held at Columbus, Ohio, January 15-18, 1907

W. M. HAYS
Secretary

H. H. MOWRY
Assistant Secretary

WASHINGTON, D. C.

AMERICAN BREEDERS' ASSOCIATION.

OFFICERS.

President: HON. JAMES WILSON, *Washington, D. C.*
Vice-President: HON. L. H. KERRICK, *Bloomington, Ill.*
Secretary: HON. WILLET M. HAYS, *Washington, D. C.*
Treasurer: PROF. OSCAR ERF, *Manhattan, Kan.*
Assistant Secretary: H. H. MOWRY. *Washington, D. C.*
Chairman Animal Section: HON. A. P. GROUT, *Winchester, Ill.*
Secretary Animal Section: DR. C. B. DAVENPORT, *Cold Spring Harbor, N. Y.*
Chairman Plant Section: HON. CHAS. WILLIS WARD, *Queens, N. Y.*
Secretary Plant Section: PROF. N. E. HANSEN, *Brookings, S. Dak.*

EDITORS.

HON. W. M. HAYS, Secretary; PROF. N. E. HANSEN, Secretary Plant Section; DR. C. B. DAVENPORT, Secretary Animal Section.

MEMBERSHIP DUES.

Annual, American, $1; Foreign, $2; Life, in any country, $20; Patron, $1000.

PREFATORY STATEMENT.

The American Breeders' Association is now three years old. It has passed through the struggles of infancy. All who peruse the contents of this report will be convinced that it is rapidly measuring up to its possibilities all along the line. Those who have attended the recent meetings of the organization and particularly the last convention at Columbus have observed how the animal breeders, the plant breeders, and the students and scientific investigators are drawing closer together in attention, personal relations, and mutual appreciation of their related problems. This situation justly affords satisfaction to our members who have confidently supported this movement from the beginning.

Of the forty-three committees organized only a year ago many have submitted reports and outlines of work which appear in this volume. Already in several cases the influence of these committees has caused work to be undertaken by private and public agencies in the field of the respective committees. Largely increased funds are needed to pay the traveling and incidental expenses of committeemen to enable them to meet together more frequently and to insure their attendance at the annual meetings; also to insure the presence of speakers whose names are placed on the programs of these meetings.

The Secretary has made and is making constant efforts to increase the membership of the Association. Members can greatly aid in the work of reaching a much larger number of breeders of animals and plants by inviting them to join and by sending in to the Secretary the names of those known by them to be interested in the objects of the organization that they may be given an opportunity to unite in this movement for improving the heredity of all useful living things. The membership thus far has been large enough to provide funds to pay the incidental expenses. A much larger membership is needed to keep pace with the increasing activities which are demanded of the society.

The Association is under very deep obligation to the people of Ohio, the citizens of Columbus, the Ohio Board of Agriculture and Board of Trade, the State University and the several agricultural societies for the courtesies extended and the successful meeting held in their capital city. Mention should be made of the conscientious and most satisfactory services of Mr. D. A. Brown, of Cincinnati, Ohio, who reported the meetings. For most valuable editorial suggestion and assistance in the preparation of this volume for printing, through the courtesy of Mr. Geo. Wm. Hill, Chief of the Division of Publications of the U. S. Department of Agriculture, grateful acknowledgment is

171407

made to Mr. S. E. Thornton of that Department. Especial thanks are due to the gentlemen who are assuming the duties on the various committees of this Association. These gentlemen are already carrying heavy work in both official and private capacities but are giving their energy and time to this new movement without compensation because of the opportunity offered to perform a large public service. The Secretary has at all times received the enthusiastic support of the President and Council in carrying on the work of the society, and feels amply rewarded for his own efforts by the steady growth of the organization in numbers, influence, and public approval.

W. M. HAYS, Secretary.

CONTENTS.

TUESDAY FORENOON, GENERAL SESSION.

Address of Welcome. By DR. W. O. THOMPSON, Columbus, O.... 9
Address of Welcome. By W. W. FARNSWORTH, Columbus, O.... 12
Response. By W. M. HAYS, Secretary, Washington, D. C..... 14
Breeding Beef Cattle in Ohio. By J. P. HINE, Shinrock, O..... 21

TUESDAY AFTERNOON SESSION, ANIMAL SECTION.

Inheritance in Pedigree Breeding of Poultry. By DR. C. B. DAVENPORT, Cold Spring Harbor, N. Y..... 26
The Production and Fixation of New Breeds. By DR. W. E. CASTLE, Cambridge, Mass..... 34
Breeding Horses. By PROF. C. W. GAY, Ithaca, N. Y..... 42
Animal Breeding and Disease. By DR. E. C. SCHROEDER, Washington, D. C..... 50

TUESDAY AFTERNOON SESSION, PLANT SECTION.

Some Results in Selecting Red Clover for Disease Resistance. By PROF. S. M. BAIN and S. H. ESSARY, Knoxville, Tenn..... 59
Importance of the Mutation Theory in Practical Breeding. By GEORGE H. SHULL, Cold Spring Harbor, N. Y..... 60
Carnation Breeding. By FRED DORNER, Sr., Lafayette, Ind..... 67

TUESDAY EVENING SESSION.

Education and Breeding. By W. M. HAYS, Washington, D. C..... 73
Rejuvenation by Hybridization. By Q. I. SIMPSON, Palmer, Ill..... 76
Heredity in Carnation Seedlings. By J. B. NORTON, Ithaca, N. Y.... 81

WEDNESDAY FORENOON SESSION, ANIMAL SECTION.

Teaching Animal Selection. By PROF. C. S. PLUMB, Columbus, O... 83
Report of the Committee on Cooperative Work in Animal Breeding. By W. M. HAYS, Washington, D. C..... 95
What Poultry Breeders Can Learn from Cattle Breeding. By ROSWELL H. JOHNSON, Cold Spring Harbor, N. Y..... 98

WEDNESDAY FORENOON SESSION, PLANT SECTION.

Report of the Committee on Breeding Sugar Crops. By DIRECTOR C. D. SMITH, Agricultural College, Mich..... 101
Breeding Sugar Beets for Increase of Sugar Content and Yield. By J. E. W. TRACY, Washington, D. C..... 102
The Improvement of Sugar Cane by Selection and Breeding. By C. O. TOWNSEND, Washington, D. C..... 105
Corn Breeding and Registration. By C. G. WILLIAMS, Wooster, O.. 110

WEDNESDAY AFTERNOON, GENERAL SESSION.

Report of Committee on Breeding Cereals. By PROF. L. S. KLINCK, St. Anne de Bellevue, Can..... 122
Report of Committee on Theoretical Research in Heredity. By CHARLES W. WARD, Queens, N. Y..... 130
Recent Advances in the Theory of Breeding. By DR. C. B. DAVENPORT, Cold Spring Harbor, N. Y..... 132

The Chromosome in the Transmission of Hereditary Characters. By PROF. W. J. SPILLMAN, Washington, D. C..... 135
Resolutions in re Eugenics and Research in Agriculture and Breeding. 137
Financial Statement 139
Tobacco Breeding in Ohio. By PROF. A. D. SELBY, Wooster, O.... 141
Breeding Kentucky Tobaccos. By W. H. SCHERFFIUS, Lexington, Ky. 147

WEDNESDAY EVENING, GENERAL SESSION.

Report of Committee on Breeding Corn. By J. DWIGHT FUNK, Bloomington, Ill..... 154
Report of Committee on Breeding for Dairy Production. By A. J. GLOVER, Hoard's Dairyman, Ft. Atkinson, Wis..... 156
Breeding Cattelo. By C. J. JONES, Topeka, Kan..... 161

THURSDAY AFTERNOON, GENERAL SESSION.

Establishing Type in Breeding Animals. By H. M. BROWN, Hillsboro, O. 165
Report of Auditing Committee..... 173
Resolutions 173

THURSDAY EVENING, GENERAL SESSION.

The Press and Breeding. By DR. W. I. CHAMBERLAIN, Hudson, O. 175
Breeding Dairy Cattle. By DIRECTOR M. A. SCOVELL, Lexington, Ky. 180

FRIDAY FORENOON, GENERAL SESSION.

Report of Committee on Animal Hybridizing. By PROF. W. J. SPILLMAN, Washington, D. C..... 184
Results of Hill Selection of Seed Potatoes. By C. W. WAID, Wooster, O. 191
Importance of Full and Accurate Descriptions of Varietal Differences in Growing Seed of Market Vegetables. By W. W. TRACY, Washington, D. C..... 199
The Inheritance of Size of Litter in Poland-China Sows. By GEO. M. ROMMEL, Washington, D. C..... 201

Papers Read by Title..... 208
The Evolution of the Bacon Type. By HON. JOHN DRYDEN, Toronto, Can. 209
Report of the Committee on Breeding Tree and Vine Fruits. By PROF. S. A. BEACH, Ames, Ia..... 211
Method of Pedigree Breeding Recommended for Improving Cotton. By DR. H. J. WEBBER, Ithaca, N. Y..... 213
Report of the Committee on Breeding Nut and Forest Trees. By GEO. B. SUDWORTH and A. D. HOPKINS, Washington, D. C..... 224
Improvement of Forest Trees. By PROF. J. RUSSELL SMITH, Philadelphia, Pa..... 227
Report of Committee on Breeding Forage Plants. By PROF. J. H. SHEPPARD, Fargo, N. Dak..... 236
Report of Committee on Breeding Bees and Other Insects. By DR. L. O. HOWARD, Washington, D. C..... 240
Report of Committee on Cooperative Work in Plant Breeding. By DR. A. F. WOODS, Washington, D. C..... 241
Cooperative Breeding of Small Fruits. By PROF. W. M. MUNSON, Orono, Me..... 244
Prevention of Degeneration the only Practical Eugenics. By MAJOR C. E. WOODRUFF, Plattsburg Barracks, N. Y..... 247
Statistics of Cotton Variation. By D. N. SHOEMAKER, Waco, Tex... 252
A Plea for the More Extended Use of the System of Live Stock Registration. By M. M. BOYD, Babcaygeon, Ont..... 255
Report of the Committee on Breeding Poultry. By PROF. JAMES E. RICE, Ithaca, N. Y..... 258

Grading in Agricultural Judging Contests. By DR. L. J. BRIGGS, Washington, D. C. ... 260
Introducing New Varieties of Plants. By C. W. WARD, Queens, N. Y. 262
Report of the Committee on Breeding Carriage Horses. By GEO. M. ROMMEL, Washington, D. C. ... 263
Report of the Committee on Breeding Vegetables. By PROF. R. A. EMERSON, Lincoln, Neb. ... 264
Report of the Committee on Breeding Horse Hybrids. By PROF. F. R. MARSHALL, College Station, Tex. ... 265
Methods in Seed Corn Breeding. By EUGENE FUNK, Shirley, Ill. ... 266
Need of Purebred Stocks of Animals in the South. By PROF. C. A. CARY, Auburn, Ala. ... 268
Report of Committee on Breeding Fiber Crops. By L. H. DEWEY, Washington, D. C. ... 270
Improvement of Citrus Fruit Varieties. By PROF. E. J. WICKSON, Berkeley, Cal. ... 271
Report of Committee on Breeding Fish. By J. W. TITCOMB, Washington, D. C. ... 276
Notes on Breeding Oats. By J. B. NORTON, Ithaca, N. Y. ... 280
Report of the Committee on Swine Breeding. By PROF. D. A. GAUMNITZ, St. Anthony Park, Minn. ... 285
Directory of Members:
Annual ... 291
Life Members ... 301
Honorary Members ... 302
Index:
Subject ... 303
Author ... 305

PROCEEDINGS OF THE MEETING OF THE AMERICAN BREEDERS' ASSOCIATION, HELD AT COLUMBUS, OHIO, JANUARY 15-18, 1907.

The annual meeting of the American Breeders' Association was held at Columbus, O., on January 15, 16, 17, and 18, 1907.

The Association was the guest of the Ohio State Board of Agriculture; and the College of Agriculture of the Ohio State University; other agricultural organizations of the State of Ohio also participated in the meetings, as will appear in the reports of the various sessions.

The sessions were held partly at the Ohio State University and partly at the Board of Trade Auditorium in Columbus.

A full report of the proceedings follows:

TUESDAY FORENOON, JANUARY 15—GENERAL SESSION.

The Association met in the chapel of the Ohio State University with the Ohio State Farmers' Institute.

In the absence of Hon. L. H. Kerrick, Vice-President, Dr. C. B. Davenport, of Cold Spring Harbor, N. Y., presided and called the meeting to order.

After music by the Angelus Ladies' Quartette, Dr. Davenport introduced as the first speaker Dr. W. O. Thompson, President of the Ohio State University.

ADDRESS OF WELCOME.

By Dr. W. O. Thompson, *President of the Ohio State University, Columbus, O.*

Mr. Chairman, and Gentlemen of the Convention: I suppose most people would agree that it is proper for the President of the University here to express a welcome on the part of the University to an Association of this sort, as it comes here to our city, and, in part, to this University, to hold its annual session; but I hope that there is something more than mere formal propriety in this case. I want, therefore, to assure you that in expressing a welcome to this Association this morning I am voicing a sentiment that has been in our hearts and our minds ever since we anticipated this meeting. We have come to regard the meeting of the American Breeders' Association as one of the important agencies in developing and cultivating interest in the objects it seeks to attain.

Nothing is more manifest, I think, than the commonplace truth that an abiding intelligence as to the problems we are trying to solve

is the condition of all enthusiasm in the work in which we are engaged; and enthusiasm in this work is the condition precedent to any great achievement. In any phase of agriculture, whether it be crop production, or animal or plant breeding, hope of eventual success must lie in an intelligent apprehension of the problems involved, and that intelligent apprehension must precede the enthusiasm necessary to make the movement succeed.

Now, we are engaged here at the University in trying to do all of these three things that you are trying to do. We are endeavoring to increase the intelligence upon these problems through the processes of education, and by increasing such intelligence to make the young men come within the immediate reach and influence of the University. We are trying to arouse enthusiasm in the business of agriculture, believing that if we can arouse genuine enthusiasm we attract to it and keep in it the best quality of men who are best suited to develop the business of agriculture.

I suppose most of us are aware of the fact that there has been lately a tendency for population to return from the city to the farm. I have never looked upon that as any serious addition to the real productive forces of agriculture. It is a pleasant thing for the city folk to talk about; but the future of agriculture is in the hands of the people who live upon the farm as farmers, and not in the hands of those men who make their fortunes in the city and who propose to go out into the country as a sort of pleasure or a secondary business consideration. The future of agriculture lies with the people who believe in agriculture and who live with it. There are no fundamental laws underlying any other business different from those which underlie the business of agriculture. Every business depends for its success upon the people who live with it and who devote themselves to it. Now, if I understand the purpose of all this agitation, of this awakening interest on the part of the State and of the Nation in the matter of agriculture, it is that we may arouse intelligent interest in agricultural surroundings and enthusiasm in those surroundings as a condition precedent to success in agriculture.

I suppose that we should say also that we intend, if we can, to bring up agriculture, as we intend, if we can, to bring up everything else. We have had a mighty hard struggle to get the medical profession on a safer basis. We have had a mighty hard struggle to get the legal profession to anything like a high standard. We are having a tendency now toward a drop in the ministry.

There is not anything in the world that does not present these problems, and we must avoid the conclusion at which some people seem to have arrived, that people in agriculture are less interested than other people are in their particular calling. The truth is that with the passing of the years new conditions have arisen in agriculture. All its products furnish problems, but every day and hour these are attacked with more or less success. One great line along which our agricultural interests are devoting attention and skill is the matter of plant production; another is the matter of animal production. The

fundamental principle that underlies improvement along either of these lines is this: If there is anything good in anything, there is more good in the best things; that is to say, if there is any good in raising any sort of an animal, there is more good in raising the best sort of an animal; if there is any good in producing any sort of a plant, there is more good in producing the best sort of a plant. Underneath this whole movement lies the fundamental fact that the best things are the profitable things. Not only are they profitable things from the financial point of view, but they are the things worthy of the attention of intelligent men. I suppose you will recognize in a moment that it does not take a large amount of brains and it does not greatly tax a man's enthusiasm to do the things that everybody has done for fifteen generations. That is a very simple process. We must be governed by some higher motive than that which suffices for the ordinary day's work, something better than the old treadmill idea, or else we will tire early of the business. What has created enthusiasm in other lines is the possibility of development in the business. You cannot get a young man now anywhere of any ambition, of any character and intelligence to permanently ally himself with a business that has no future in it. Nor can you get the farmer to permanently ally himself with the farm unless there is something there of a future—not simply a money future, but a future that is worthy of him as an individual.

Now, if this farmer can understand that he has the opportunity to do business of a high character, and to deal with materials of a high character, there will be some satisfaction in the business. We believe, therefore, that in the development of plant breeding and of animal breeding we are doing something to meet the needs of the men who live in connection with this business, as well as doing something to meet the higher needs of society.

I suppose we may take a larger outlook this morning, and in addition to the one I have just suggested, say that the development of these industries is an important consideration for the country at large. That fact is the reason why the State gives its money toward it; that fact is the reason why the Nation gives its money. We tax people to support public educational institutions as a matter of necessity because such institutions develop the country. An organization of this sort is, therefore, an aid to the development of the country. The Department of Agriculture is one of the influences which has for its purpose the development of this country.

Now a fundamental principle with the Government is that we must keep our patrimony undiminished, must keep our country in a high state of development, in order that the Nation itself may live. Whatever is done, therefore, by way of education, by way of stimulus, by way of instruction, as is done through our schools and colleges, or through our Department of Agriculture and other Departments, is done for the development of the country; and to the extent that these develop the country they make the country stronger. Through them the country reaps a benefit in the perpetual prosperity of its citizenship.

I want to emphasize, therefore, in this welcome, that you are not

here simply for any selfish or narrow reasons, but because this organization is one of the great developmental agencies of our country. We are in sympathy with it because it makes for the prosperity of the entire community and the preservation and development of its resources. This is the reason for your existence.

Let us, therefore, assume this morning that we are engaged in no trivial discussions here, because the problems that will come before this Association at this convention will be such as relate to the permanent welfare of our entire country; and whatever is good for the country is good for you and me, and good for all the institutions of the country. Therefore, we are enthusiastic about these fundamental branches of agricultural industry, two of which are represented in this convention this morning.

Now, as Professor Hays has just come in since I began speaking, I shall renew my welcome in order that he shall not escape, and in order that he shall feel along with the rest of you that he is welcomed to Columbus and to the State of Ohio by the State Board of Agriculture, the Ohio State University, and the Columbus Board of Trade, all of which bodies have been, I assure you, most earnest in their preparations for this meeting and most cordial in their welcome. If there is anything that has not been done by any of these associated organizations that can be done, and you will kindly make it known, I am sure that any of us, or all of us together, will respond most heartily.

Again I extend to you in behalf of all the people interested a most cordial welcome. (Applause.)

In the absence of Mr. W. G. Farnsworth, President of the Ohio State Farmers' Institute, speaking in behalf of that organization, Mr. W. W. Farnsworth, Secretary of the Ohio State Horticultural Society, offered the following:

ADDRESS OF WELCOME.

By W. W. Farnsworth, *Secretary of the Ohio State Horticultural Society, Columbus, O.*

I do not want to appear under any false pretenses this morning, and will simply say by way of extenuation that the President of the Ohio Farmers' Institute was unable to be here this morning, and I was requested to try to fill his place.

Gentlemen of the American Breeders' Association, the farmers of Ohio bid you welcome here this morning. We have been accustomed to meet here from year to year to study some of the problems which we find confronting us in our daily duties and occupations upon our farms, and in respect to which we are endeavoring to secure more light which shall guide us: for in our present condition we realize that the one thing necessary for our highest success is more light.

We have great hopes for the younger men, and I am delighted to see so many of them here this morning. I feel that it speaks much for the future of Ohio agriculture. We have great hopes that they may take up the work which we may only do imperfectly, and that they may advance our chosen calling to that high plane which we hope to see it occupy.

Our farmers have always acknowledged the truth of the old saying that "mind is greater than matter"; but we have not at all times been wont to associate it as closely with our calling as we should have done. We have felt in the past, in the clearing of the forests and in the accomplishment of the greater portion of our farm work, that brawn and muscle played a very important part; but as we have progressed in civilization, as machinery has to a great extent taken the place of muscle, we have realized more and more that it is he who thinks and plans rather than he who digs and delves that is able to reach the highest plane of success in agriculture and horticulture.

We have been in a weak blind way striving to avail ourselves of all our opportunities; we feel that a great deal has been accomplished in the last decade, and we hope to do greater things in the future. When we look around us and see the great advances that are being made and the great work that has already been done, we feel sure that many of us will live to see the realization of our dreams.

Now, gentlemen, in behalf of the tillers of the soil who are gathered here this morning from the four corners of our State, I wish to repeat again to you the welcome which has been so ably extended by the President of our State University, and to express the wish that the intermingling here for the few days during which we may be together will be productive of great benefit to all who are enabled to participate. (Applause.)

DR. DAVENPORT: Several years ago there entered into the minds of the men engaged in agricultural pursuits and who led in the agricultural industries of a great State the idea of combining all of the forces devoted to breeding, not only the farmers but also the men of science, into one organization to promote the interest that all have in common.

The result of that idea was the foundation of the American Breeders' Association, which held its first meeting some three years ago in St. Louis. The heart and soul, the intelligence, that drives this Association is with us to-day. He has been promoted from his position as leader of agriculture in his State to the position next to the leader of agriculture in the United States. I introduce to you Professor W. M. Hays, Secretary of the American Breeders' Association, who will respond to the addresses of welcome.

RESPONSE TO ADDRESSES OF WELCOME.

By HON. W. M. HAYS, *Secretary American Breeders' Association, Washington, D. C.*

LADIES AND GENTLEMEN: The American Breeders' Association is proud to meet with the farmers of Ohio in the great University of Ohio. We are proud to meet with the organizations here represented—the Ohio State Board of Agriculture, the Ohio State Horticultural Society, the State Farmers' Institute, and the other organizations of this State.

Personally, I am delighted to be here, both to meet the members of the American Breeders' Association and the people of this State, including the farmers and the students of this great University. I am always pleased to meet your President, knowing what work he is carrying forward not only for agriculture, but for all lines of educational effort. I know of his place in national and educational affairs, and I am glad to tell you how much he is appreciated, how the people not only believe in him and admire him, but love him.

I am glad to be here with the professors of your State University and the workers in your State Experiment Station and your Farmers' Institute, the members of your State Board of Agriculture, and all these gentlemen who are taking the lead in this great work.

We come here with some enthusiasm. Our members are to represent us on this program and they come here with a great message—a message to Ohio, a message to this country, a message to the world.

The world is only waking up to what it can do, not only in engineering, but in agriculture; not only with the soil, but with those living forces bound up in our plants and animals which we can select out, and at little expense make into more valuable forms, blessing humanity with greater production.

This organization was formed to bring together the powerful forces of mind and life; to operate on the living plants and animals; to bring out the best there is in them. The world is learning not only to respect science, but to have the profoundest expectations of science. It is really astounding to those who have been in this work of advancing agriculture in our State experiment stations, agricultural colleges, and the National Department of Agriculture, to see the wonderful forward movement that has taken place in the minds of our people, and in the faith they have in science as applied to the soil, to the crops and to the animals. (Applause.)

I see before me some of the older professors in the Agricultural Department of this University. I do not mean that they are old men, but I mean that they have been longest in the business; and they and I know how difficult it was to arouse enthusiasm and interest in matters agricultural twenty-five years ago. This quarter of a century has won for agricultural science a permanent, strong, and inspiring place in our civilization. Some other lines of work went forward more rapidly than did those beginning ten, fifteen, or twenty years ago in the

breeding of plants; but there is no line to-day that is going forward more rapidly nor gaining larger place in the experiment stations and in the curriculum of our agricultural colleges.

Young men will make no mistake who take up this line of work. Those of us who by reason of our position are shown what progress is liable to take place in the interest of agriculture in the near future can see far greater opportunities, far greater prospects, than could these older professors and myself when we were students in agricultural colleges a quarter of a century ago.

You must all admit that agriculture is a wonderful theme; that the science of plants and animals and the management of farms and country homes have in them wonderful breadth of thought and work, and that once this subject is fairly opened up, and the energies and money of the rich people of America are turned in that direction, there will be plenty of opportunity for young men and young women all along the line; opportunity for young men in large numbers in the more humble positions, and every great opportunity for those who can become leaders of the first rank.

The members of the American Breeders' Association appreciate what was said on this platform by these two gentlemen this morning; but we appreciate more deeply the spirit with which this State has taken up the invitation to bring this Association to Columbus to meet with the Agricultural Society and other societies, and to meet at the university with the agricultural college people of this great institution; and I want to say as secretary of the Association, having had charge of arrangements on the part of the Association, that we are delighted with the treatment we have received, with the spirit in which the State Agricultural Society has simply given up part of its program and allowed this Association, the members of which come from many States, to seem to be the larger factor of the program, that we might preserve our identity throughout the entire country.

We appreciate especially the work of the gentlemen who have had immediate charge of these arrangements. Men are not always broad-minded. These gentlemen have been very broad-minded, and I may say magnanimous and kindly in this matter, and we thank you most heartily.

We wish to thank this city also for the courtesies it has extended; for the nice notices which the newspapers have already given this meeting; for the interest that your commercial bodies have taken; and we want to say that we are proud that we are here in the great State of Ohio.

It is with very great regret that I must announce that we do not have with us the President of this Association to-day—Secretary Wilson. He sends you his greetings. He is very sorry he cannot be with you. It has not been his fortune to be at any of the meetings of this Association. He has recently suggested that he wished we might meet in Washington, that he could meet with us. I might say it was through Secretary Wilson's suggestion that this organization was formed under the auspices of that great organization—the American Association of

Agricultural Colleges and Experiment Stations. He suggested that this matter be taken up by a Committee of that Association, and under its great name it was possible to do what seemed then very difficult—to bring together the practical breeders of plants and the practical breeders of animals, the scientists studying the breeding of plants and scientists studying the breeding of animals, and scientists studying heredity in a general way. We owe much to this parent organization. We should at no distant day pay our respects to that organization in some commensurate way. It has been suggested that we might possibly meet with the American Association of Agricultural Colleges and Experiment Stations next November in the city of Washington. I assure you that nothing but the greatest Departmental responsibilities at this time would have kept Secretary Wilson from being at this meeting at least one day; but there never has been a time when there was more work to do in the Secretary's office than during this last month or two, owing to the administration of these new food laws and meat laws as well as the presence of Congress and the taking up at this time of the appropriation bills for the Department of Agriculture.

I am compelled also with the deepest regret to report that Vice-President Kerrick, whom we always expect at these meetings, and whom we usually expect to take the general burden of the proceedings in his most happy way, to our great sorrow will not be here on account of the serious illness of Mrs. Kerrick. He sends his greetings and wants to be remembered to all the members of this Association, and he is glad to have his name mentioned to the people of this great State. It has been the loyal support and the great faith that these leaders have had that has made it possible to bring this Association forward as rapidly as it has developed.

This, ladies and gentlemen, is the fourth annual meeting of this Association. It has already published two reports, the first including accounts of the first two annual meetings. The great trouble with the organization has been the immense distances which people have to travel to attend any national organization. Notwithstanding the difficulty of bringing out very many members, great interest is shown in the Association as appears from our rapid increase in membership, and even more from the great interest which the people of this country are taking in this Association and the subject it represents. You may be sure that at first there were many people who doubted the expediency of forming a National Association. They thought this country was too large for a National Association of any such general character as this would be. I think that those people almost without exception have been converted to the idea that the move was a good one. It has taken some of them three or four years to find out that the subject matter, the great economic and theoretic interest in this subject has made possible such an organization.

Now, ladies and gentlemen, as to the present meeting; you see by the program that there are to be presented a large number of papers by able men, and, as these papers come on, the purpose is to discuss them. I am sure you realize that the scientists and practical men in

plant breeding and animal breeding are surely getting hold of the subject in a technical and practical way that none of us dreamed of five years ago.

This meeting will do the main work of first blocking out what direction this Association is to take. At the last meeting there were appointed something like forty committees. These committees have been invited to report at this meeting. It is not probable that all of them will succeed in bringing reports; but there will be a sufficient number of reports to show how this subject is to be approached, not only by this Association, but by these committees. They are bringing together the brightest minds on the different lines involved in the subject of breeding. These committees will bring these men into a position to consult with each other and to bring about consultations with others who may be leaders along the same lines.

The great work of crop breeding, of taking our varieties and species of field crops, horticultural crops, and various other crops, and the great work of breeding domestic animals, is going to be done partly by individuals, but largely by institutions—private corporations, or public institutions; and these committees will help to interest these individuals, and corporations, and institutions. They will also help the farmer toward what we might call standard systems and working methods of getting at his problems, stating the object to be reached and the way of approaching that object. Then this Association will help to do another thing. It will help to develop new varieties and breeds by means of statistics and figures gotten during the process of scientific breeding, figures that will tell the American people that these new forms are more valuable, and that the people cannot afford to disregard them, because there is great money in them.

The scheme of committees has been worked out in three classes: (1) General committees on both animal and plant breeding; (2) committees on plant breeding; and (3) committees on animal breeding. One of the first committees, for example, under the general heading is the Committee on Animal and Plant Introduction, headed by Mr. David G. Fairchild, who is prepared for this work by two or three times going about the world, his expenses in part being borne by the National Department of Agriculture, and in part by a California millionaire, who finding this young man and gaining his enthusiasm, paid the expenses of some of these trips, Mr. Fairchild getting only his salary from the National Department of Agriculture. This matter of plant introduction is only well begun, having been started by J. L. Budd, Professor of Horticulture, and by Mr. Charles Gibb, who together went twenty-four or twenty-five years ago to Europe and Asia to find new things for the northern climates, especially in fruits. Then Professor Hansen, Mr. Fairchild, and other gentlemen in the Department of Agriculture followed with trips abroad, and they have thoroughly opened up possibilities and plans for bringing to this country whatever good there may be in natural species in all parts of the world. We are not going to do all the breeding of plants and animals, for a great work

in this directions is being accomplished in Europe by the immense city corporations and by private individuals there.

Another general committee is that on animal hybridizing. The movement has only started to bring to this country wild animals from foreign countries. The work of bringing the improved animals has been going on for a long time; but we have not got all the best there is along that line even yet. Foreigners are continuing their improvements. The zoological parks of Washington, New York, Cincinnati, Chicago, and other great cities should keep in line with the economic as well as scientific sides of this question, and bring into their collections not only those foreign animals that are of interest to people to see, but those which can be used in hybridizing experiments in order to find out what animals can be hybridized; and what are the possibilities of making them useful in improving the blood of our domestic species. At the head of this Committee on Animal Hybridizing is Professor W. J. Spillman, of the United States Department of Agriculture at Washington, a man who has shown strong instincts for studying this matter of hybridizing and its possibilities.

There is a Committee on Breeding for Dairy Production, headed by T. L. Haecker, of St. Anthony Park, Minn.; a gentleman who has made great progress in methods of feeding and has simplified methods of testing the value of the cow. Professor Haecker did not realize that the methods he was working out in solving the problem of cost of production were the very methods in part needed to compare cow with cow and blood line with blood line in dairy breeding. He has now been brought in relation to the other gentlemen on this committee and is trying to block out a system of breeding dairy cattle.

Professor Andrew Boss, also of the University of Minnesota, for twelve or fifteen years, has had charge of an abattoir in an agricultural college, teaching young men and young women about meats; young men how to judge animals before slaughter, how to slaughter them, and how to judge them after slaughter; how to put them upon the block and judge the pieces; how to weigh the pieces and get at their valuation so as to get at the value of one animal as compared with another, in order to determine which is the best animal. Professor Boss has been asked to take charge of the Committee on Breeding for Meat Production. He has with him a number of other gentlemen who have had experience along this line. He has hardly realized till lately —as none of us have—the possibilities of applying scientific tests in regard to performance, if you please, of meat-producing animals. It was all along claimed that we must not go by outward appearance of these meat-producing animals as seen in the show-ring and in public and private sale in judging of their values; but those of us who have seen the method of figuring out trotting records and performances in our horses have felt that this method might be applied to meat stock; also especially such meat stock as combines both meat and milk production. I would say that Professor Boss has charge of the first experiment—no, not the first, because the first is in Colorado—in which the Department of Agriculture and the State experiment stations are

to work out a system of breeding in co-operation. But it is the first in this respect, that it undertakes to apply performance records to meat-producing animals, recognized as one of the very difficult problems. The problem taken up is with milking shorthorns, and I may have occasion to speak of it later on in this meeting.

The next committee mentioned is the Committee on Co-operative Work in Animal Breeding, of which I happen to be Chairman, and of which I may speak more at length later on.

Then there is a committee headed by Dr. A. F. Woods, Assistant Chief of the Bureau of Plant Industry at Washington, on Co-operative Work in Plant Breeding; not only co-operation between the Department of Agriculture and the State experiment stations, but co-operation of whatever kind between different institutions—possibly between the Department of Agriculture and private individuals, or organizations other than experiment stations.

There is a committee also to study questions relating to heredity in man, and something will be said concerning that committee and its organization later on.

Professor C. S. Plumb, of the University of Ohio, is at the head of the Committee on Nomenclature and Registration. There is need of uniform terms that everybody will understand and of somewhat uniform and certainly efficient methods of registration that will keep track not only of lineage and pedigree, but of performance records—performance pedigrees if you please. Professor E. W. Major, Berkeley, Cal., of the University of California, is at the head of the Committee on the Pedagogics of Breeding—the teaching of breeding. Professor D. A. Gaumnitz, of St. Anthony Park, Minn., has charge of the Committee on Prize Competitions. Professor C. F. Curtiss, of Ames, Iowa, of the Iowa Agricultural College, long associated with the breeding interests of Iowa, as well as with the Agricultural College and Experiment Station, and particularly with the great International Livestock Association of Chicago, in which organization he is a very prominent and useful member, has charge of the Committee on Purebred Livestock Business—the business side of livestock breeding. This will include such questions as how to bring before the public those blood lines which are really most useful to the farmer, or, in other words, how to make money out of the breeding business in a businesslike and excellent way.

There is a Committee on Purebred Seed and Plant Business, of which Mr. Eugene Funk, of Shirley, Ill., is chairman, which, for instance, will deal with the relations of public institutions producing new varieties to the seed house and to the men throughout the State who become breeders of plants, in the same way as our purebred stock breeders are disseminators of purebred animals.

Dr. H. J. Webber, of Ithaca, N. Y., is chairman of a most important Committee on Theoretical Research in Heredity. There are three great steps in these studies that are inspiring such men as Dr. C. B. Davenport, who is presiding to-day, to go forward and learn more of what takes place in heredity. These are explained in the works of

Darwin, Mendel, and DeVries, particularly those of DeVries. These studies are being followed up more and more by experimenters who are taking up that line of work and who believe that heredity can be brought under scientific control; that there is even arithmetic in it. Characters are often inherited and transmitted mathematically, at least to some extent. So these men on this committee are taking up many other phases of the subject of heredity, and they are going to do much of the groundwork that will make possible improvements in the breeding of plants and animals, just as theoretical chemistry has made possible modern chemical engineering.

Mr. George M. Rommel, of the Department of Agriculture at Washington, is chairman of the Committee on Breeding Carriage Horses. Work has already begun in that line in Colorado, as many of you know. Professor John A. Craig, of College Station, Texas, has charge of the Committee on Breeding Draft Horses.

There is to be a Committee on Breeding Fur Animals—wild animals. The fur animals of the world are becoming extinct. People are becoming wealthy and want more furs. It is just as legitimate to breed and grow fur-producing animals as it is to breed cattle or any other class of animals.

There is a Committee on Breeding Fish. I dare say that when this work is taken up in earnest that an immense number of fish that can be used in breeding experiments will be found and the problem will be so worked out as to secure practical as well as theoretical results. Mr. J. W. Titcomb, of Washington, D. C., is the chairman of this committee.

So I might go on at length, with the forty committees, which illustrate the scope of this Association. There is practically a committee for each class of animals—dairy animals, beef animals, each class of work animals, each class of plants, such as corn, cereals, clovers, etc. I urge gentlemen here who are interested in any of these lines to find members of these committees and get in touch with them.

I mentioned that there has been a suggestion that we ought to hold a meeting of this Association at Washington possibly next year. It has also been suggested that at some time within a few years it would be wise to hold under the auspices of this Association a great international gathering on animal and plant breeding and heredity.

I want to say in conclusion, Mr. Chairman, that we are delighted to be here. (Applause.)

CHAIRMAN DAVENPORT: I feel that this meeting would wish me to express its regret at the enforced absence of President Wilson, which fact has been brought before us by Secretary Hays. I do not need to tell a meeting composed very largely of farmers how glad we should be to see President Wilson, recognizing the grandeur of the work that he has done for the American farmer. He has told us somewhere that when he first came to Washington as Secretary of Agriculture he found

the Department consisted largely of a set of roll-top desks. Since he has been there he has not only filled those desks with the most prominent agriculturists and organizers of agricultural work, but he has organized practical work, gardens, green-houses, farms, and filled them with scientifically trained men who have been engaged in studying the fundamental laws underlying the industry of agriculture.

I am sure also that this meeting would wish to express its deep regret at the absence of Vice-President Kerrick, and its sympathy at the cause, and its hope that that cause may soon be removed in the complete recovery of his family.

After music by Angelus Ladies' Quartette, the presiding officer announced Mr. J. P. Hine, of Shinrock, Ohio, as the next speaker.

BREEDING BEEF CATTLE IN OHIO.

By J. P. Hine, *Shinrock, Ohio.*

Mr. Chairman, Ladies and Gentlemen: It is with a great deal of pride that I step upon the platform of this old chapel. Twenty-three years ago I attended as a farmer's boy a course of lectures—farmers' lectures—delivered in this chapel. Of that course of lectures I took copious notes—and put them away so carefully that I never could find them. I remember just one topic, and that I remember a great deal of. That was furnished by Brother Chamberlain. The next year as a student of the University here, and again two years later, I attended all the meetings in the same course. Some of these were held in the city hall in this city with only a handful—a score or so—of the prominent breeders of the State. I have seen the work grow until it requires larger accommodations. So I feel that while I am not very aged in years, that I was present at the birth of the institute movement of the State of Ohio, and have always kept my interest in the institute, not only of the State institute but of our local institute as well.

For twenty years I have been breeding and handling pure-bred cattle of one of the popular beef breeds, and for more than ten years exhibiting in the show yards of many of our best State and district fairs. I have kept in close touch with the beef producers of the country. So while my experience has been largely in the production of breeding animals for the improvement of the beef stocks, I recognize the fact that the aim and end of all beef-producing cattle is the block and that the success and prosperity of the breeder rests, in the end upon the prosperity of the actual producer and finisher of the beef animal.

Let us start with the axiom that all prosperity is founded upon the bounteous production of mother earth and that the agricultural products (in all branches) comprise a large percentage of this production, and that the greatest possible agricultural prosperity for the masses

cannot endure without the rearing and feeding of livestock, of which the beef animal comprises so large a portion. The agricultural progress of any country is marked by, and is largely the result of skill in producing superior live-stock.

In the early days of live-stock improvement in America, Ohio and her sister State on the south, were the leaders of beef production. Good beef-producing cattle dotted the pastures of Ohio, from east to west and from the river to the lake. Then came the highly specialized dairy breeds and their indiscriminate mixing with the beef-producing stock of the State, until we had—what? Brother Gould says "Succotash," and that expresses it very well.

Ohio was fast losing her prestige in beef production to the newer Western States, when in the early 80's the general revival of interest in the beef animal led to the importation of large numbers of pure-bred cattle of various degrees of merit, and where we had one beef breed before, we now have four. Ohio gets her full share of all. The rivalry that sprung up between the various breeds—usually but not always friendly—has wrought great changes and improvements in which all have shared. All have aimed at the same standard until to-day the typical animals of the various breeds are much alike in general conformation and excellence. In this general improvement Ohio has held her own in competition with the faster-growing and more progressive States of the West, sending out her herds of the various breeds to do battle in the show rings of the country—those greatest schools for improvement and advancement, always winning a share of the laurels and always returning to prepare for more strenuous battles to come.

Ohio, the gateway between the East and the West, may well feel proud of her record in the past, and gain encouragement and inspiration for the future. When we consider her widely diversified industries and interests, her record in fine live-stock production is certainly good.

The demands of the market are constantly becoming more exacting. The range in prices of fat cattle is becoming greater each year. Why is this? No other meat-producing live-stock shows such varying prices according to quality. To-day the quotations on beef cattle in the Chicago market read something like this: "Inferior and rough beef steers, $4 to $4.40"; "choice to prime beeves, $6.25 to $7.15." Margin enough here you may think between $6.25 and $7.15, but how great the difference between $4 and $7.15, the two extremes. These are the prices of beef cattle and do not include "stockers and feeders." In another place under the heading of "stockers and feeders," you will find prices ranging from $2.50 to $4.85—showing more money is paid for good well-bred feeding cattle than for poorly-bred fat ones.

If you would turn to the quotations on hogs you would find them something like this: "270-pound to 330-pound packing, $6.45 to $6.50; 220-pound to 250-pound average, $6.45 to $6.47½; fair to fancy heavy shippers, $6.50 to $6.55; rough heavy packing odd lots, $6.20 to $6.25." How small the margin of difference! Thirty-five cents per 100 pounds covers it, barring pigs, throw-outs, etc. It leads one to think of the old saying, "A hog is a hog the world around." With cattle some ap-

pear to be cattle, while others, and the great majority, too, are so in name only; or in other words, some are beeves, while others are only partially so.

Will cattle improvement continue to that point where the fat animals will approximate the uniformity of price displayed by the fat hog? I say "approximate" because the very natures of the animals are so different as to forbid a close comparison. Here is a vast field for the educator and breeder.

Let us turn again to our market report, to the quotations on heifers. We have "Heifers inferior to fair mixed, $2.35 to $2.80; fair to good, $3.00 to $3.55; good to choice selected, $3.60 to $4.40; extra prime selected, $4.50 to $5.25." Compare these quotations with those quoted above: "Choice to prime beeves, $6.25 to $7.15" (steers, of course); "extra prime heifers, $4.50 to $5.25"—a difference of nearly $2 per one hundred weight. Can any one explain to me the justice of that? Is there any good reason why there should be so great a difference? You may say the heifer does not kill out so well as the steer or make so good a carcass. Did you ever, in any wholesale or retail shop see a side or quarter of beef labeled heifer or cow? Did you ever think for a moment that the average person can tell the difference between two quarters of beef hanging in a shop, one from a heifer and one from a steer of the same breeding and quality? "Oh," you say, "the point is that you can't finish a heifer to the same perfection as a steer." But I have fed too many heifers (open heifers) for exhibition in the breeding classes and have seen too many perfectly fitted and finished beauties in the yearling and two-year-old classes of the show rings to believe that.

For the past eighteen years a majority of the grand champion winners of the Smithfield (London) fat stock shows have been heifers, most of them open heifers at that. Could a heifer win the highest honors at our own international, think you? I say here is the greatest imposition the beef producer who grows his own cattle has to contend with. It is a relic of the "Dark Ages" of cattle breeding. Such discrimination is not practiced in other classes of fat stock. The market quotations on sheep or swine show no distinction between the sexes on young stock. Britain has outgrown such discrimination. How long will American beef producers permit themselves to be hoodwinked and buncoed out of $2 per hundred weight on one-half the cattle they grow?

While we are discussing markets we must not lose sight of the fact that after all the home markets of Ohio take a very large percentage of home production, and it is a debatable question, whether our towns and cities do not buy more dressed meat shipped in from without the State than is shipped out of the State alive. With such good home markets and such a market as Pittsburg close at hand, we have a great advantage over many of our sister States farther west. With a wide range of forage and feeding crops and abundant and nutritious grasses, and with farming and grazing lands that have not advanced in value as rapidly as those of equal merit in the West, we have an added advantage which is a very great one.

Next to water, light, and air, the greatest gift of nature is grass. An abundance of grass throughout the entire growing season is a prime factor in cheap production of beef. The practice of feeding grain on grass will very materially lessen the amount of grain necessary to finish the animals for the market. Right here I want to state that the fly pests which cost cattle so much of the gain of the earlier part of the grazing season can largely be controlled, if the cattle are fed a little corn, by having small pigs running with them to turn over and spread the droppings, causing them to dry up and thus destroying the larvæ of the flies. The Texas horn-flies have become especially bad of late years and they worry the flesh off stock not protected from them in some way. I experimented one season with a fly trap for catching them. Many of you will smile at the thought of catching flies off of cattle with a trap, but this Canadian invention was quite successful in controlling the fly pest on all cattle that came to the yard or barn every evening, and on such as were well halter-broken and might thus be led through the trap the first few times until they learned that it was equal to rubbing up against a straw stack.

Of course, the use of this fly trap would be impracticable with herds of any considerable size, as also is spraying for the average breeder or feeder.

The prosperity of the country demands an ever-increasing proportion of the choice cuts of beef and the production of the type of animal carrying the largest percentage of the high-priced cuts is ever the aim of the breeder and feeder of high-class cattle, and is pursued at the expense of milk production. It may seem queer to speak of milk production in connection with the subject of the specialized beef animal, but, while I am not here to say that we are ready for the dual-purpose animal for growing beef, I want to say that an abundance of milk taken in the natural way is essential for the quick development of young stock of any kind; and the breeder of any of the beef breeds who allows his herd to become less and less productive of milk will find that he has an expensive and mortifying proposition to deal with. A long milking period is not essential or desirable as is the case with the dual-purpose dairy cow, but a good flow for three to five months is very desirable. The development of the prize winner often calls for much more milk than the dam will produce and for a longer period. This has had a tendency to bring in outside aid in the form of nurse cows. This should be permissible only for the development of the young show animal.

Quite a large percentage of the cattle fed in Ohio are raised in other portions of the country. And while there will always be a natural drifting of thin cattle from the cheaper grazing lands to the corn-producing farms, the future supply of feeding stock might well concern us at the present time. And there are many indications that we will have to look more and more to our home supply for feeding stock.

Many will argue that we can't afford to grow our own when we can buy so cheaply in the markets, and all steers too as that same question

of heifer beef hits us hard at every turn. But there are many advantages in home, or near-by production which are patent to you all and the discussion of which would occupy more time than is allowed me for this address. One of the greatest of which is the opportunity it gives us to have the right class of feeders thus permitting us (to quote the famous saying of our honorable chairman) to "Grow beef rather than fatten cattle."

Just now we are enjoying the special privilege—appreciated by only a few, however—of obtaining at very reasonable prices, quality and breeding considered, range-bred calves that can be profitably grown into excellent finished "long yearlings." How long we may enjoy this privilege no man can tell, it may continue and even increase for several years to come. The annual migration of aged steers from the southern breeding to the northern grazing fields has practically ceased. This gives the southern rancher who sells his increase as calves the opportunity to devote all of his range to his breeding cows, thereby doubling or trebling his increase each year. And as we better appreciate the quality and uniformity of his product, the demand for it will rapidly increase and the East will get an ever-increasing portion of his product. On the other hand, the great wave of "land hunger" that is sweeping over the country and the development of irrigation projects and "dry farming" systems is making great inroads on the domain of the rancher and will not only rapidly curtail his area of production but will produce the feed to grow and finish a portion of it for the markets. So I believe the time is approaching when Ohio must breed more of her beef cattle, and with the recognition accorded the live-stock interest of the State by this our great university, although somewhat tardy, and the ever-increasing influence of the institute work, our education should keep pace with the progress and changes. And if we do that, there is a bright future for Ohio in the production of beef—"choice to prime" beeves—regardless of sex. Then will the beef-producing interests see the bright sun shining once more and regain their full share of the general prosperity of live-stock production.

The next matter taken up was the appointment of an auditing committee to examine the treasurer's report. The Chair appointed Professor C. S. Plumb, Professor Q. I. Simpson, and Professor W. E. Castle.

Announcement was made that the Council meeting would be held at luncheon time in Townsend Hall.

Professor McCall made several announcements relative to luncheon and routine matters, time and place of meeting of the various sections, etc.

On motion, recess was taken until 2 o'clock p. m.

TUESDAY AFTERNOON, JANUARY 15—SESSION OF THE ANIMAL SECTION.

The Animal Section met in University Chapel pursuant to adjournment, in conjunction with the Ohio State Farmers' Institute, and was called to order at 2 o'clock p. m., by Secretary Hays, who introduced as the presiding officer, Hon. A. P. Grout, "a breeder and Farmers' Institute worker, a general hustler for agriculture out in Illinois."

CHAIRMAN GROUT: The first thing upon the program is an address by Dr. C. B. Davenport.

INHERITANCE IN PEDIGREE BREEDING OF POULTRY.

By DR. C. B. DAVENPORT, *Cold Spring Harbor, N. Y.*

No excuse is necessary for presenting an address on this subject before an association of practical breeders. The breeding of poultry has become in America one of our leading animal industries, an industry probably exceeding in value that of beef production. The breeders of poultry are vastly greater in number than breeders of any other kind of live-stock; indeed, it is the one sort of animal breeding that is practiced by a large proportion of suburban and rural residents. Consequently any additional knowledge gained concerning the principles of poultry breeding, and, in particular, the inheritance of their characteristics must be of wide interest.

To the student of heredity also, fowls are of exceptional interest, both on account of their great fecundity and the number of different characteristics they show. As to fertility, during a breeding season of five months one may expect an average of 75 eggs and may hope to hatch from 25 to 50 of these. Moreover, I know of no other group of domesticated animals, except possibly the pigeon, that approaches the chicken in number of varieties. The recognized varieties are numbered by scores, but the scientific breeder is less interested in varieties than in characteristics. Every organ seems to exhibit a number of well defined types. Let us take, for example, the comb, an organ not found in other birds. We can recognize such distinct types as the single comb; the pea comb, of triple nature; the rose comb, made up fundamentally of five combs, all fused together in the adult and producing a flat mass covered with tubercles. There are also the walnut comb of the Malay, the V-comb of the crested races, the leaf comb of the English Houdans, and even the combless condition. Almost any other organ shows similar variety. The iris may be pearl, salmon, red, brown, black, or mottled. The ear-lobes may be joined to the wattles or separate; inconspicuous because nearly absent, or of great size as in the white-faced Spanish; in color they may be red, white, greenish-blue, black, or mottled. And so I might go on with each organ or part.

Not only in structural but also in dynamic qualities there is similar variability. Some birds are wild like the Leghorns, others exceedingly quiet and gentle like most of the Silkies. The Cochins tend to brood their eggs frequently; the Leghorns rarely or not at all. Some cocks have a short crow, in others it is much prolonged (as in the Tosa fowl to 10 seconds); in others it gains individual character and musical quality. It is clear that such variety gives the breeder an opportunity to make very desirable combinations if only he knows how to engraft on his stock any quality that he may find among poultry. The general method of such engrafting is, of course, hybridization; and it is of some of the laws governing hybridization in poultry that I wish to speak to-day.

In general, the different forms of inheritance that may be recognized in hybridization are as follows:

1. *Inheritance is alternative*, that is, one of the two contrasted conditions of a given organ is dominant over the other and alone appears in the progeny. When rose comb and single comb are crossed the offspring have a rose comb.

2. *Inheritance is particulate*, that is, both of the contrasted characters appear in the offspring side by side in a patch work. When a game and a white Cochin are crossed the feathers of the progeny are often barred.

3. *Inheritance is blending*, that is, the opposed characters being quantitatively unlike, the offspring are approximately intermediate between the two parents. Heavy boot and light boot give intermediate boot.

4. *Inheritance is neomorphic*, that is, a characteristic appears in the hybrids that cannot be seen in the bodies of the parents. Single comb crossed with V-comb gives a Y-comb.

Let us now consider the behavior of various characteristics of poultry when they meet in hybridization.

INHERITANCE OF PLUMAGE COLOR.

The primitive plumage color seems to be that of the Jungle fowl or old English game, viz., black breast and tail and red-laced hackles, saddles, back feathers, wing coverts, and outer one-third of secondaries of wing. White is a sport which appears in two forms: A dominant white seen in the white Leghorn and most white races, and a recessive white, as seen in the white Silky. Wholly black birds appear in certain races, as black Minorcas and Spanish, Cochins, Javas, etc. Wholly or nearly buff birds are found in the Cochins and various races derived therefrom. In addition to self-colored black, white, and buff, a great variety of feather patterns is recognized such as barring or alternating light and dark bands across the feather, which bars may be black and white, black and buff, buff and white, etc.; pencilling or concentric alternating light and dark bands; lacing or a margining of light color —buff, golden, or silver; shafting, or a light stripe along the shaft of the feather; spangling, or a dark spot at tip of feather, the center

being light, or the reversed. Also there are regional patterns. Thus the feathers of the hackles and saddle region, usually alike and laced, are frequently different from those of the rest of the plumage. In inheritance these areas are independent of the other areas of the body. In the Dark Brahmas these areas appear as the lightest of the plumage because of the broad white lacing. In the Light Brahmas all of the plumage is white except the tail and the black white-laced hackles. The wing bar, which is red in the Jungle fowl, may be white as in the Dark Brahmas. All of the black of the Jungle fowl pattern may be replaced by white as in the Pile Game; or all of the golden lacing of the Jungle fowl may be replaced by white, as in various silver-laced birds.

If a self-black, like a Minorca or a Black Houdan, be crossed with a white Leghorn the offspring will ordinarily be white. But if a self-black Minorca, Spanish, Cochin, or Game be crossed with a white Silky the offspring will be black with more or less red in those situations in which it is found in the Jungle fowl. Darwin observed the appearance of some red in the cross between a black Spanish and a Silky and referred to it as a typical case of reversion. The reason for this reversion seems to be the dilution of the black, revealing a red that lies hidden in the black. One may say that ordinarily white dominates completely over black, but silky white dominates only over the excessive melanic condition by which the fundamental Game red-and-black pattern is hidden. The Silky has not the power to disturb the underlying pattern: for when a Game is crossed with a Silky, there is no important difference between the offspring and the Game except that its red is slightly darker than that of the typical Game.

If a self-black be crossed with a buff—a color that is characterized (like the Silky) by an absence of the black—the veneer of black is removed from the fundamental pattern and the red-laced hackles and saddles appear in the offspring. Buff acts like the silky white, and can remove superflous black, but is too weak to dominate over the underlying game pattern. If a self-buff be crossed with a White Leghorn the result is a blend; the offspring is a lighter buff; white is not dominant over buff. Thus different grades of potency or dominance are found in color. While white is the strongest, red is hardly inferior; the basal black is next, and silky white and superficial black are least potent.

The results of mating parti-colored with self-colored birds may now be considered. Each of the colors behaves in its particular area as though it were the self-color. Thus if a Game is crossed with a White Leghorn, white dominates over black, but not over red, consequently the hybrids are white wherever the Game is black and red or buff where the Game is red. Sometimes the result is more complicated. I crossed a Japanese long-tailed Game—Tosa fowl—with a white Cochin, and all of the male hybrids were black-and-red as in the Tosa, but every feather was barred with white. The female hybrids were very like the female Tosa fowl.

I crossed a Black-Breasted Red Game with a Buff Cochin and in the

hybrids the black was partially replaced by buff. Thus the breast was buff with a sprinkling of black, while the wing feathers were over half black. Buff partially dominated over the black of the Game plumage. When a black-and-red Game is crossed with a black, the first generation of hybrids shows the red areas much reduced by the encroachment of black. The Dark Brahma has a modified Game plumage, red being mostly replaced by white. When crossed by black the hybrids are black save for a little red that still persists on the wing bar of the Dark Brahma. Consequently it may be concluded that the white of the Dark Brahma is a weak white dominated by black, while the red is only imperfectly dominated by black.

Similarly the colors of the feather patterns may be made what one will. For the gold hackle-lacing of the Jungle a white lacing may be substituted, or the lacing may be left of a golden color while the black center is replaced by white. The white center remaining, the gold lacing may be replaced by black. Finally, if white be replaced by golden, the normal relation of the colors of center and lacing may be reversed. Again, a black-and-white barred bird may be made red-and-white, or red-and-black barred. In a word, pattern and color in poultry are independent units and any of the poultry colors—white, black, and red—may be attached to any pattern or to any of its elements.

INHERITANCE OF COMB FORM.

When a single comb is crossed with a rose or a pea comb it is recessive so that the first generation of hybrids shows only the rose or the pea comb. When the hybrids are mated together, however, one-fourth of the offspring have a single comb; and such single combs bred together thenceforth transmit only the single comb. Single and rose comb constitute a typical allomorphic pair and behave in Mendelian fashion.

When a single comb is crossed with the V-comb of the crested races of fowls, the hybrids all have a comb that is single in front and divided or cleft behind, *i. e.*, the Y-comb. This is a new form. Bred together two Y-combs give rise to single combs, V-combs and Y-combs again. This is apparently a case of particulate inheritance.

When a rose and a pea comb are crossed a strikingly new form appears—the short, broad, hairy walnut comb. This, like the Y-comb, is due to two dominants striving to appear in the soma simultaneously. The result is an intermediate condition. The different comb forms are thus inherited as unit characters and in Mendelian fashion.

PLUMAGE FORM.

In addition to the plain plumage of ordinary fowls, there are feathers that are reversed in curvature, being convex toward the body; such feathers have the barbs also twisted. This condition of the feathers is known as frizzling. In another form the barbs gain a great length,

repeatedly bifurcate and do not hang together. Such a condition is known as silkiness.

When plainness of feather is crossed with frizzling, all offspring are frizzled—frizzling is dominant. When plainness is crossed with silkiness, plainness is dominant. Plain X frizzle hybrids when interbred produce 25 per cent plain. These extracted plains when inbred produce nothing but plains. But the plain-feathered hybrids of plain and silky produce 25 per cent silky. And these silkies inbred produce only silkies. Consequently, the different forms of plumage are unit characters, are alternative in inheritance, and are transmitted in Mendelian fashion.

THE CREST.

When crested birds (Houdans, Polish, and Silkies) are mated with crestless, the offspring are all crested. Such crested birds mated together have about 25 per cent of the offspring without crest. Crest is a unit character inherited in Mendelian fashion.

OTHER CHARACTERS.

Other Mendelian characteristics are the beard and muff of Houdans, the cerebral hernia of the crested races, the long feathers at the heel known as "vulture hock," and the skin-color. Among physiological characteristics, the sitting instinct appears to dominate over the non-sitting tendency.

But there are certain characteristics of poultry that are not alternative and seem not to be inherited in Mendelian fashion. Thus, the feathered foot ("boot") when crossed with plain foot gives rise to offspring mostly booted, but usually with the boot much reduced. The hybrids bred *inter se* produce mostly booted offspring feathered in all degrees, the intermediate degrees being commonest. Booting is thus a blending character.

Extra toes occur on certain races such as Dorkings, Houdans, and Silkies. When fowls with the extra toe are mated with normal, the hybrids are either normal or abnormal. The extra toe is an alternative characteristic. But it seems, nevertheless, not to be inherited in accordance with Mendel's law. The proportion of extra toes derived from any cross of plain and extra depends on the strength of the extra-toed strain, and can be largely predicted by observing the size of the extra toe.

MENDELIAN INHERITANCE.

Although Mendelian inheritance with dominance and recession of unit characters is, as we have seen, widespread yet in almost no case is the dominant character in the hybrid like that of the parent; it is frequently much changed. Thus the pea comb resulting from a cross of pea and single is a high pea comb; the frizzled hybrids have the

barbs less twisted; the crest of the hybrid is always much reduced and the same is true of the muff, vulture hock, and skin color. Even in the second hybrid generation, the " pure " individuals that are gained show a damaged condition of their characteristics. The warning that Professor Castle gave before the Breeders' Association two years ago that crossing impairs characteristics in mammals is amply justified for poultry also.

Notwithstanding the damage wrought upon characteristics by hybridizing, yet, since hybridizing is the only practicable method of getting desired combinations, it will continue to be used. It remains to consider the best method of improving the characteristics of hybrids. It would seem to follow from the Mendelian doctrine that little progress can be made by selecting the best appearing individuals, for inheritance, it is said, is a matter of germ cells and nothing can be told concerning the germ cells by inspection of the body. White fowls with a black parent look like white fowls with a Game-colored parent; yet the former bred *inter se* produce blacks, the latter Games.

CENTGENER POWER.

It is often stated that selection must be made not on appearance of the body but on breeding performance—on centgener power as our Secretary phrases it. By this method, if we wish to improve a damaged white plumage we do not breed from the hybrids with the whitest plumage, but from hybrids that produce the largest percentage of pure white birds. To this general principle I adhere, but with some limitations. The determination of centgener power is most important, but centgener power in respect to external characteristics of form and color can frequently be predicted with more or less precision from an inspection of the body of the hybrid. I may illustrate this by citing a case that is supported by numerous experiments. It will be recalled that when a single comb and a V-comb are crossed, the hybrids have a Y-comb, and that Y-combs crossed together yield single, Y, or V, in the average proportions of 25, 50, and 25 per cent respectively. The Y-comb behaves in Mendelian fashion. It will be recalled also that the proportion of the comb that is split may vary from 5 to 95 per cent. It now appears that if two hybrids with slightly split combs be bred together there will be more than 25 per cent of single-combed offspring; but, on the contrary, if two hybrids with deeply split combs be bred together, there will be less than 25 per cent of single-combed offspring. For example, of 43 offspring from a pair of hybrids whose combs were on the average only 30 per cent split, 40 per hundred had single combs. Whereas, of 112 offspring from a pair of hybrids whose comb was split on the average 75 per cent, only 17 per hundred had single combs. Clearly the centgener power to produce single comb can be predicted by an inspection of the combs of the parents. The average of the progeny of all hybrids mated at random gives close to the Mendelian proportions, but the centgener power of all hybrids of the

first generation is not alike and the differences may be inferred from inspection of such hybrids. I find this rule to hold generally, in the cases of nostril height, of crest, of foot-feathering, of number of toes, and of plumage color. The centgener power of a characteristic depends on the development of that characteristic. To improve a characteristic we should breed from those individuals that produce the largest percentage of offspring showing the desired improvement; or breed from those individuals which most nearly approach the ideal. The individuals selected by the two methods will usually be found to be identical.

FIXING DESIRED CHARACTERS.

Now, although the foregoing method will give the greatest proportion of the best offspring, yet by any method the offspring of the first and subsequent generations of hybrids will be very variable. How can a desired combination be "fixed" so as to establish a race? The fixing of the recessive characteristics is easy. They will appear in certain individuals of the second generation of hybrids; and if such individuals be bred together they will reproduce in their progeny such recessive characteristics as they possess; so far as these recessive characteristics go the race is "fixed." But if there are also dominant characteristics to be "fixed" in the race, the procedure takes more time. For example, let it be desired to make a pure white strain from the hybrids between White Leghorn and Black Cochin. We start in the first hybrid generation with white birds; breeding them together we get some blacks, which henceforth breed blacks as a pure race. The whites are of two kinds—homogametous or "pure" and heterogametous or those having mixed germ cells—and in general it is difficult to say which is which from inspection. If two whites bred together produce some blacks both have germ cells of the two kinds. But if they produce only whites, then the one or the other or both are pure, but which of these three possibilities is true cannot be said. A surer way of detecting purity of white is to breed the white hybrids to various blacks; if any individual yields only white offspring that individual has only white germ cells. One "pure" white female and one "pure" white male may become the progenitors of a "pure" white race in which pigmented individuals will never occur. By a similar process a race may be made pure with respect to any dominant characteristic.

POTENCY.

One other factor, as yet little understood, deserves attention—the factor of potency. There can be no escape from the fact that, even in alternative inheritance, certain parents will produce offspring in accordance with Mendelian expectation, whereas other parents will fail utterly to do so. I may illustrate this with a case in my experience. I acquired from a breeder two rumpless Bantam Game cocks so alike

that they were doubtless closely related, if not brothers. I bred the one that seemed the stronger to some White Leghorn Bantams and to Black Cochins and obtained 48 hybrids all with well developed tails. I regarded rumplessness as recessive. The next year I mated the yearling hens with one of their brothers, expecting to get 25 per cent rumpless. Eighty-six offspring were obtained of which not one was rumpless. I mated some of the Black Cochin and Rumpless hybrids with their father, expecting to get 50 per cent rumpless offspring. Of 99 offspring not one was rumpless. At this time I was ready to conclude that rumplessness was not inheritable. But I decided to substitute for the cock that I had mated to the Black Cochins the other rumpless cock. I obtained from this union 46 offspring of which 24 or over 50 per cent were rumpless. The germ cells of the second cock were certainly much less potent in their tail-producing tendency than those of the first.

Not only may the germ cells of one individual differ, as a whole, in potency from those of another, but individual germ cells may differ in potency from the other germ cells elaborated by the same parent. Thus, in crossing Houdan females with a high nostril, and a White Leghorn male with a low nostril I obtained 40 offspring all with a low nostril and Y-shaped comb. The "low-nostril" determinant of the germ cell is dominant over the high nostril determinant of the egg cell. But the 41st hybrid had a high nostril and V-comb. In this case, therefore, the nostril determinant of the egg dominated over that of the germ. The relative potency of this one egg in respect to nostril was greater than that of any other egg. These illustrations will suffice to make it plain that there is such a thing as prepotency and it follows that the formation of a race containing a certain desirable character will be accelerated if an individual can be obtained whose germ cells are potent in respect to that character.

SUMMARY.

In conclusion, let me bring together the processes necessary for the creation of a new race which shall combine various desirable characteristics found in two or more races. They are three in number: (1) hybridization by which the desired combination may be obtained, at least in the second hybrid generation; (2) purification of the race by the elimination of germ cells carrying the characteristics that are opposed to those sought; and (3) selection of the best appearing individuals as parents by which there will be obtained a larger percentage of offspring of the best quality. And, finally the work of obtaining and fixing a desirable characteristic will be hastened if there can be found some individual which is prepotent in respect to that characteristic.

At the close of Dr. Davenport's address, Chairman Grout introduced Dr. W. E. Castle to deliver an address on a closely related subject.

THE PRODUCTION AND FIXATION OF NEW BREEDS.

By W. E. CASTLE, *Assistant Professor of Zoology, Harvard University, Cambridge, Mass.*

The art of animal breeding has been practiced by man since the earliest dawn of civilization. In many cases its products attained centuries ago a degree of excellence which we can scarcely hope to surpass, as in the horses of Arabia and the poultry of China. Of course, these and other breeds have since been modified in useful directions and are capable of further useful modifications; but for the needs of the time and place where bred, the horses and the poultry of centuries ago were probably not inferior to our own. In creating new breeds of domesticated animals, we are merely adapting to new and special conditions very ancient and excellent breeds. This is a work of the highest importance, and I have no desire to minimize it. But while we contemplate with satisfaction present attainments and prospects, let us not forget our debt to the past for taking wild species into domestication and moulding them to meet man's needs. To those unchronicled pioneer breeders we owe entirely the material with which we work.

We stand at the beginning of a new era in which breeding will pass from the condition of an art into that of a science. The difference will be that we shall know the reasons for our procedure, whereas the breeder of the past did not. We shall continue to produce breeds just as he produced them, but we shall know how we produce them, a thing of which he was largely ignorant. His work was largely haphazard; ours will be orderly. He experimented until he got what was wanted or until he found his ideal unattainable; we shall produce what we want, and knowing what is attainable will not attempt the impossible. He progressed indirectly, awaiting the caprice of chance; we shall go straight to the goal, knowing the way beforehand.

No finer swords, perhaps, were ever made than those which the Saracens produced six centuries ago at Damascus and Toledo, but to produce steel of the many varieties now in use, and in the quantities required by the diversified industries of to-day would have been a task beyond the powers of the Saracen either to accomplish or to imagine. Scientific knowledge of metallurgy has brought about the change; no less revolutionary does the application of scientific knowledge to the art of animal breeding promise to be.

The first great advance made toward such a knowledge was taken by Gregor Mendel when he discovered the principle of unit characters in heredity, the principle, namely, that the various physical and physiological characteristics of individuals are transmitted in heredity as distinct units. An individual is nothing but the sum total of these unit characters, which it receives from its parents and hands on to its children. The ordinary individual has two parents and, for each unit character, it receives a contribution from either parent. When

the contributions made by the two parents are similar in character or when they unite to form a blend in the offspring, we are apt to overlook their separate existence. It is easiest to demonstrate the existence of units when a different contribution is made by either parent and when the inheritance is alternative between the two parental contributions. It was in this category of cases that Mendel's discovery of the principle of unit characters was made.

The practice of breeders had long accorded with the principle of unit characters, because that practice gave desired results. Now came a wholly unpractical man of science, a recluse, but a man who could give a reason, and that reason (the principle of unit characters) marks the first and greatest step yet taken in the transformation of breeding from an art to a science. Breeders knew that crossing of dissimilar parents induced variation; from variations so induced selection might be made of such variations as were desirable and these might be fixed by inbreeding. Further than this the analysis of the matter had not been carried. We now know, thanks to Mendel, that the variation following crossing is due largely to the production of new combinations of unit characters. Thus, in rats, to take an illustration from my own experience, coat pigmentation and coat pattern are distinct unit characters separately heritable. A cross between parents unlike in both particulars makes the matter entirely plain, leading to the production in offspring of the second generation of all the possible combinations of the units in question. A wild self-gray rat mated with a tame black hooded [1] one produces offspring all with the wild color and wild color pattern (though usually slightly modified); but when these young are bred together, there are produced in the next generation, four sorts of young representing the following combinations:

(1) Wild color and wild pattern.
(2) Tame color and wild pattern.
(3) Wild color and tame pattern.
(4) Tame color and tame pattern.

By selection, any or all of these combinations may now be fixed. The empirical breeder's idea that fixation of a new variation can be secured only by inbreeding, we now see, rested on a misconception. It is not the relatedness of parents which results in fixation, but the fact that they represent like combinations of characters. We might cross one pair of rats in Massachusetts and another one in California, and bringing the hybrids together in pairs secure complete fixation of the new varieties produced without ever pairing relatives. Here we get from the principle of unit characters a practical suggestion worth remembering, which allows fixation of characters without inbreeding.

Not all characters give alternative inheritance; in the case of some a blend (or condition intermediate between that of the two parents)

[1] A "hooded" rat is white all over except on the head and shoulders and along a median dorsal back-stripe, in which regions it bears either black or gray pigmentation.

results from a cross. This seems to be true in mammals as regards general size, dimensions of the skull and long bones, of the tail, and of the ears. A variation produced as a blend needs no fixation. It breeds true from the start, as I pointed out at our meeting two years ago in the case of ear-length of rabbits. In the case of blending characters no less than in that of alternative ones, the principle of unit characters holds good. Hair color, hair length, and coat pattern, are in rabbits independent unit characters, which can be combined in any desired way in conformity with the laws of alternative heredity. Ear length is another unit, distinct from all three hair characters and capable of combination in any desired way with them, but harder to manipulate simultaneously because of its blending nature. I pointed out at our meeting two years ago a method of fixing simultaneously characters which blend and those which do not.

Perhaps the most important extension which has been made of Mendel's law consists in the demonstration (chiefly by Tschermak, Cuénot, and Bateson) that certain characters are produced only when two or more separately heritable factors are present together. Such a character does not conform with the simple Mendelian laws of inheritance, but its factors do. Herein lies the key to the explanation of so-called heterozygous characters and to the practical process of their fixation. This same principle serves to explain also atavism or reversion, and the process by which reversionary characters may be fixed.

When purebred black guinea-pigs are mated with red ones, only black offspring are as a rule obtained. The hairs of the offspring do indeed contain some red pigment, but the black pigment is so much darker, that it largely obscures the red. In other words black behaves as an ordinary Mendelian dominant. In the next generation black and red segregate in ordinary Mendelian fashion, and the young produced are in the usual proportions—three black to one red. All black races behave alike in crosses with the same red individual, but among red animals individual differences exist. Some, instead of behaving like Mendelian recessives, produce in crosses with a black race a third apparently new condition, but in reality a very old one, the agouti type of coat found in all wild guinea-pigs, as well as in wild rats, mice, squirrels and other rodents. In this type of coat, red pigment alone is found in a conspicuous band near the tip of each hair, while the rest of the hair bears black pigment. The result is a brownish or grayish ticked or grizzled coat, inconspicuous and hence protective in many natural situations. Some red individuals produce the reversion in half of their young by black mates, some in all, and others, as we have seen, in none, this last condition being the commonest of the three. It is evident that the reversion is due to the introduction of a third factor, additional to simple red and simple black. It is evident further that this new third factor, which we will call *A* (agouti), has been introduced through the red parent, and that as regards this factor, *A*, some individuals are homozygous (*A*-*A*) in character, others are heterozygous (transmit it in half their gametes only), while others lack it altogether. Further observations show that it is independent

in its inheritance of both black and red; it is in fact an independent Mendelian character, which can become visible only in the presence of both black and red, because it is a mosaic of those two pigments.

The chart (Fig. 1) is intended to show how the independent factors behave in heredity. The black parent contributes the factor *B;* the red parent, *R* and *A*, so that the zygote, or new individual, contains the three factors necessary to the production of agouti. When the new individual forms gametes (sex-cells), these will be of four different kinds, for *A* is independent of *B* and of *R* and may pass out with either one in the reduction division which separates *B* from *R*.

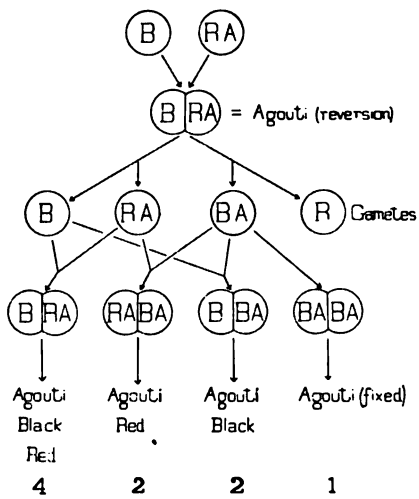


FIG. 1.—Diagram showing how the three independent characters, B (black), R (red), and A (agouti), are transmitted in the production and fixation of an agouti race. A circle represents a reproductive cell (gamete); gametes united in pairs form zygotes (new individuals). The first horizontal row shows the kinds of gametes which unite to produce the reversion (second row). In the third row, are shown the four kinds of gametes formed by the reversionary individual; and, in the fourth row, the four kinds of agouti individuals produced by different combinations of those gametes. Below are indicated their expected numerical proportions and the kinds of young which they will respectively produce in crosses with red individuals (R).

That division accordingly may occur either so as to form gametes *B* and *RA* respectively, or what is equally probable so as to produce gametes *BA* and *R*. Observation confirms this interpretation, for it is found that the reversionary agoutis do not breed true, but produce young of the three sorts—agouti, black, and red, as expected. We expect black individuals from unions of *B* with *B*, or of *B* with *R;* we expect red individuals from unions of *R* with *R* or with *RA*, and from unions of *RA* with *RA;* we expect agoutis to be produced by any gametic union which brings together the three factors *B*, *R*, and *A*. There are 4 chances in 16 for the occurrence of such a union, when the reversionary agoutis are bred together. In fact, however, agoutis are produced much oftener. Approximately 9 out of 16 of the young

have been found to be agoutis. The unexpected excess of agoutis in our experiments was fully explained when these second generation agoutis were tested individually. It was then found that they are of three sorts as regards breeding capacity. The first sort produces the three kinds of young, agouti, red, and black; the second sort produces only agouti young and red young; and the third sort produces only agouti young and black young. A fourth sort, known to exist but not yet obtained in these experiments, will produce only agouti young, *i. e.*, will represent the fully fixed agouti type.

In the chart (Fig. 1) I have indicated certain gametic unions which would lead to the production of these four classes of agoutis. The probable frequencies of their occurrence on the basis of chance are 4: 2: 2: 1. Only a few animals of this generation have yet been fully tested, but it is clear that the class indicated at the left in the chart is as expected the largest, and the class indicated at the right (not yet obtained) will be the smallest.

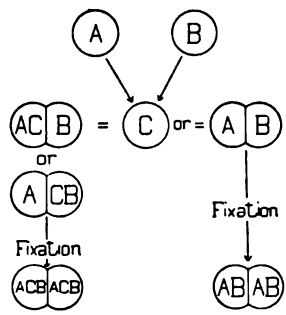


FIG. 2.—Diagram illustrating the nature of heterozygous characters and the mode of their fixation. For explanations, see text.

These experiments make it clear that *R* as an independent gametic factor is not necessary to the production of the agouti character, but that any gametic union which includes both *B* and *A* will produce an agouti individual. Yet a microscopic examination of the agouti hair shows that red pigment is present in a distinct band near the hair-tip. As a matter of fact all black individuals, even when they breed true, probably form some red pigment along with the black, but its presence is overlooked when the more opaque black is distributed throughout the whole length of the hair. When, however, black is excluded from the hair-tip, the red then becomes visible as the agouti marking, elsewhere the hair appears black. Red, then, we may assume, is always present with black in sufficient quantities to produce the agouti marking if the factor *A* is present (absence of black from the hair-tip). This explains why blacks never give the reversion in any sort of cross, but it is always brought about through the agency of the *red* parent. If a black individual contained the factor *A*, it would not be a black individual, but an agouti one.

The existence of a third factor, *A*, in cases of reversion in coat-character among rodents has been heretofore overlooked merely because it does not represent a distinct pigment or set of pigments, but consists in a particular kind of pigment distribution on the individual hairs. The agouti hair is due to a definite cycle of activity of the hair follicle in forming its pigments, first black, then red, then black; the wholly black hair is due to a continuous process of pigment formation without alternation in the character of the pigments produced. The relation between agouti and black is precisely the same as that between short hair and long hair, due likewise to differences in follicle activity, as I have elsewhere shown, but inherited quite independently

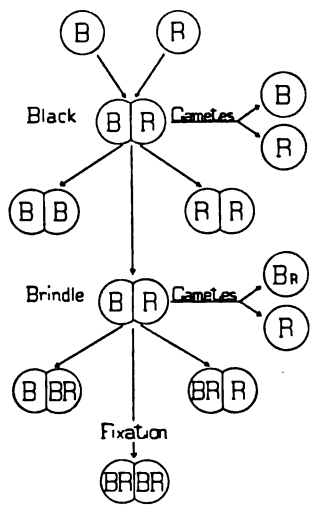


FIG. 3.—Diagram showing how the characters B (black) and R (red) are transmitted in the production and fixation of a brindle race from a self-black and a self-red one.

of hair pigmentation. Short hair is the result of a determinate growth cycle; the hair grows so long and then stops growing; long or angora hair is the result of indeterminate activity on the part of the hair follicle; the hair keeps growing so long as its follicle is alive.

We are now able to give a rational explanation of the origin of the various color varieties of rodents. The wild cavy transmits in all its gametes the three factors *A*, *B*, and *R*. By accident (mutation) a gamete has been formed which lacked *A*. When two such gametes come together the result was a black individual, and this individual would breed true. Here is the explanation of our occasional black squirrels, porcupines, and the like. If by a further mutation *B* is lost, leaving *R* alone, a red race is produced which will breed true and will not give reversion on crossing with blacks. Such are ordinary red guinea-pigs.

But if mutation is directly from the wild or agouti condition, *ABR*, by loss of *B*, leaving *AR*, then there is produced a red not different from ordinary reds in appearance, but which will give reversion in crosses with black.

The albino (or wholly white) mutation, which is frequently found in wild as well as in tame rodents, is not due, as might be supposed, to simultaneous loss of the three factors *A*, *B*, and *R*, for albinos can be shown to possess some one, some two, and some all three of these factors. They have, according to Cuènot, lost a certain other factor necessary for the production of pigment of any kind, an activating or ferment-like factor.

It has been observed that one mutation is often followed by another. DeVries in his "Mutationstheorie" speaks repeatedly of periods of mutation. We can begin to see the significance of this; given one mutation, we can produce others. Suppose, for example, that we possess agouti and ordinary red varieties only and desire black, we are not compelled to await a mutation to produce it; we can cross red with agouti and obtain black in the second generation. This is not hypothesis merely; its correctness has already been in part demonstrated. Thus, in one experiment, there was employed an agouti of the formula *AB-AR* (which gave only reds and agoutis in crosses with red), but the agoutis so produced when mated in the same way as the parent gave blacks as well as reds and agoutis, for they were of the formula *AB-R*. From such animals homozygous blacks (*B-B*) are readily obtained.

To produce a red variety from agoutis and blacks alone would not be so easy; it would be necessary either to await a mutation or to work by the slow process of selection from continuous variations in the intensity of blacks under cross-breeding with agoutis. In mice and rabbits as well as in guinea-pigs, red (or yellow) varieties are well-known, but in rats yellow has never been obtained separate from black, though black and agouti varieties are common, both wild and in captivity.

We now know what the fixation of a heterozygous character implies. When *A* and *B* are crossed, we obtain *C*. *C* is due either simply to co-existence of *A* with *B*, or to the co-existence with them of a third factor introduced with one or the other. In either case fixation will consist in getting into the gamete all the factors which produce *C*. On the first hypothesis, the zygote is *A-B* (Fig. 2), and the resultant is equivalent to *C*.. Fixation will consist in getting a zygote of the formula *AB-AB;* every gamete formed will then bear the equivalent of *C*, viz. *AB*. On the second hypothesis, the zygote is either *AC-B* or *A-CB*, (Fig. 2) ; fixation will consist in obtaining a zygote *ACB-ACB;* every gamete formed will then contain the three factors *A*, *C*, and *B*. This latter case is illustrated in the production of fixed agoutis from a cross of black with red, as already explained (Fig. 1).

The first mentioned case is well illustrated in the production of homozygous (*i. e.*, fixed) brindles from crossing of black with red

(Fig. 3). A single cross of black with red (when not attended by reversion, *i. e.*, when the factor *A* is not present) produces commonly black individuals of a reddish hue, as already stated. These individuals form gametes of the two sorts, *B* and *R*. Repeated crossing, however, is apt to produce blacks which bear patches of red hair interspersed with the black. Such animals we may call brindles. Breeding these together we may obtain (1) brindles which produce brindles and blacks (*B-BR*, Fig. 3); (2) those which produce brindles and reds (*R-BR*, Fig. 3); and (3) brindles which breed true, *i. e.*, are fixed (*BR-BR*, Fig. 3). The fixation is really due (1) to contamination of black with red, so that gametes containing black contain also fragments of red along with the black; and (2) to the formation of a zygote out of such contaminated gametes.

To recapitulate, where Mendelian (or alternative) inheritance is involved, new characters are produced by cross breeding in one of two ways: First, a new character may be produced by the becoming visible of an element previously invisible in one of the parents; or second, the characters brought together by the cross may form a mosaic different from either parental condition by itself. Fixation of the new character will consist in either case in securing gametes which separately contain all the factors necessary for the production of the new character.

The question now arises: How long will it take to secure fixation? To this we may reply: All will depend upon how the new character has been produced; if by bringing together factors previously separated (as in the agouti reversion), complete fixation may be secured in two generations. If, however, the new character is a mosaic of alternative conditions (as of self-red and self-black) fixation will probably require much longer; one cannot in advance say how long. In this case, gametic contamination is involved, the production, out of a $B + R$ zygote, of *B* gametes containing fragments of *R*, or of *R* gametes containing fragments of *B*, instead of the theoretical pure *B* and pure *R* gametes. We cannot say in advance how soon this contamination will occur. All we can say is that the more sharply alternative the inheritance and the more complete the dominance in a first cross, the less likely is contamination to occur, for experience shows that where dominance is most perfect, segregation is most complete. Gametic contamination is non-Mendelian, it borders on *blending* inheritance, and will occur most speedily when the inheritance deviates most from the Mendelian type. When the inheritance is completely blending no fixation at all of the hybrid character is required; it is already fixed.

Chairman Grout announced that the Ohio Jersey Cattle Club would meet at 7.30 at the Hotel Chittenden, and that visitors would be welcome; also that the Horse Breeders' meeting would be held at the Hotel Hartmann at the same hour. He then announced an address, on "Breeding Horses," by Dr. C. W. Gay, of Columbus, O.

BREEDING HORSES.

By PROF. CARL W. GAY, *Ohio State University.*

The subject, breeding horses, is too broad to admit of a general discusion, therefore I shall confine my remarks to the breeding of one class of horses only, namely "the American heavy-harness horse." I am prompted to choose this particular line of discussion by a deep, personal interest in this horse and by a knowledge of the fact that it is the least understood of any of our market types.

Bearing this fact in mind I shall proceed, first of all, to inform you as to what sort of a horse it is and its utility value.

The basis of all market classification is utility. Horses are required to do a particular kind of work. Experience has shown a certain type of horse to be best adapted to each of the various kinds of service. Hence there arises a strong demand for horses of definite types and there are created market classes designated by the kind of work to which horses of that class are best suited. Thus we have in the draft class, horses of such weight and build as to be most powerful in moving heavy loads; in the saddle class, those types found to be most useful for work under saddle; in the light-harness class, horses of the speed type; and in the heavy-harness, coach or carriage class, the type of horse which is to be the subject of this paper.

The heavy-harness horse is, in his highest estate, a horse of fashion and we find his greatest usefulness in the pursuit of pleasure rather than profit. However, he takes so important a part and occupies so prominent a place in the sports and pastimes of such a large number of American people as to make him of almost universal interest. Furthermore, his production offers a profitable field to those who cannot indulge in his possession for pleasure alone, so that we may be concerned with this horse either as a means of gratifying a love of sport or as a business proposition.

The term "heavy harness" becomes more comprehensive when we understand the utility of the horse to which it is applied. Any horse's usefulness depends primarily upon its powers of locomotion and its special adaptability to various kinds of work is determined by the relative importance of the speed or the draft power with which it moves. By the law of correlation, speed and power stand as extreme opposites. It is a matter of give and take between them. For instance, if we strive to attain two minute speed in our horses we impose the minimum weight, while the draft horse, of which the maximum power is required in the moving of great loads, must be permitted to perform his work at the minimum speed—the walk. With regard to relative pace and draft the heavy-harness horse occupies an intermediate position. The vehicle to which it is put is designed more for the comfort and pleasure of the occupants than for speed in transportation. It is built on lines of dignity and

elegance, properly proportioned and correctly appointed. Since, as the English say "to drive handsomely one must drive heavily," some size and substance is necessary in the horse in order to furnish sufficient power. Furthermore, in moving this somewhat heavy carriage, a reasonable pace must be maintained, hence some speed and considerable stamina are required. It is necessary, also, to consider, not only what the heavy-harness horse is called upon to do, but the manner in which he does it. It is just as essential that he should look the part as to act it. To make the best possible general appearance requires beauty of form, symmetry of finish, style and action, together with the most perfect mouth and manners. In order to complete the harmony of the equipage, the harness, by means of which horses of this type are put to the appropriate vehicle is, in contrast to the light speed harness, "heavy," in that there is more of it, it is more elaborate in design, and metal mounted. Thus the adjective, heavy, refers to the harness and not to the horse. Therefore, the horse of corresponding type must have enough size and substance to qualify for the work, be sufficiently close and full made to look the part and best perform the service, possess that quality, style, proud, bold but tractable temperament, and high, true, even, balanced way of going which insures a faultless performance and at the same time fills the eye of the connoisseur. These are the essentials that must be bred for if we are to succeed in producing the heavy-harness horse.

Possesion of a clear conception of the correct type being the first and most important factor in successful breeding, we will take the horse already described as our ideal and continue with a consideration of the means by which we may best succeed in its production.

There are two classes of breeders: first, those whose business it is to meet the immediate demands of the consumer; second, those who are devoting their efforts to the production of breeding stock, that is representative animals capable of perpetuating and improving the breed. It is important to distinguish between these two classes since the methods employed are not the same in each case. For instance, some of the most useful horses and profitable butcher beasts are produced by a most extreme cross which, in the second generation, invariably results in individuals of the most varied types and inferior character. The purpose of this paper is to treat, not only of the production of market horses, in the first generation, but the establishment of a definite breed of fixed type and prepotency.

American horse breeders have already achieved notable successes in their creation of the standard bred trotter and pacer, recognized as the light-harness type and speed champion the world over, and the American sadle horse, unique in his combination of beauty of form and utility of purpose. Other horse-producing countries have evolved types of heavy-harness horses; shall we not do the same?

Some knowledge of the original sources of the blood which has entered into all established breeds is of fundamental importance in this connection. The lighter, faster breeds have derived the greater

part of their inheritance from the Oriental horse, either Barb, Turk or Arabian. His, is the so-called hot blood which we associate with speed, stamina, quality, refinement and a nervous temperament. All these characters are in striking contrast to the great size, coarseness, growth of hair, and sluggish, lymphatic temperament of the Flanders horse, which has been drawn upon in the formation of the draft breeds. The ponderous Belgian and Shire owe their characteristic weight and massiveness to the cold blood which they possess; the thoroughbred, on the other hand, possesses only such characters as may be attributed to hot blood; the coach breeds have an admixture of both in varying degrees; while the old diligence type of Percheron represented perhaps the nearest to a balance between hot and cold blood, but as the demand for a heavier horse increased, a stronger infusion of cold blood was made and the type altered accordingly.

From our knowledge of the type, we may conclude, that, in the establishment of a breed of heavy-harness horses, the sources of hot blood would be most heavily drawn upon.

We estimate our possibilities in production, by our resources, and in order to determine these, we must look back into history. It is interesting to note, that, although there were no horses on this continent at the time of its discovery, there are fossil remains of a prehistoric horse in many of the states of the union. The first recorded importations were of the horses brought over by Columbus on his second expedition in 1493. He was followed by DeSoto and, subsequently, by the colonists, so that American horse history is more or less parallel to the history of American colonization.

From the nationality of the earliest explorers, we know that the horses, with which this continent was first stocked, came from Spain and derived their blood, in all probability, from Oriental sources. We find the most important of the original stocks to have been the English race horse or thoroughbred, taken by the English colonists into Virginia and Massachusetts. We recognize in the horses brought to Canada by the French, decendants of the old Norman and Breton stocks. The horses of the Dutch in New York, undoubtedly carried Flemish blood, derived from the old cold blooded, wild, black horse of Flanders, which originally inhabited the region of the Netherlands. These facts give us some idea of the composite nature of our foundation horses, and indicate to us, that the American horse is as cosmopolitan in its origin as are our American people.

At a later period, we find it possible to make a more definite classification of American horses. About the cities of New York and Philadelphia especially, where improvement in the construction of roads and vehicles had been most marked, a light-harness type was being created; on the frontier of Kentucky the foundations of a saddle breed were being laid; along the Conestoga, the Pennsylvania Dutch were breeding the nearest approach to the draft type which had yet been produced in this country; while, on our western plains, ranged wild, great bands of horses, decendant from those liberated by early explorers or escaped in later conquests.

If we were to enumerate the material available at the present time for the breeding of an American heavy-harness horse, we would have the thoroughbred, the most important of the composite parts which constituted our cosmopolitan base and one which has always been bred to a high state of perfection in this country; the standard bred, resulting from a thoroughbred top cross upon native mares showing an especial aptitude to trot, speed being the standard of selection; the American saddle horse, produced by a thoroughbred mating with native mares possessing a natural instinct to amble and thus develop handily the saddle gaits; the Morgan, claimed to be of thoroughbred extraction, antedating both standard bred and American saddle horse in origin, and of inestimable value in the foundation of them both; and the Americo-Arab, a later day creation which is at the present time attracting considerable attention. These may be regarded as our native resources in blood.

In considering the means at hand, with which to achieve our purpose, we must not lose sight of the fact that heredity is not the only natural force with which the breeder is concerned. We have in this country, the proper soil ingredients for the growth of bone in sufficient amount and of the finest texture, abundance of feed stuffs, a temperate climate and medium altitude, which altogether constitute an environment admirably adapted to the economic production of most superior horses.

It is to the utilization of these resources, that I wish to devote the remainder of my time. In the first place, suppose that we confine ourselves to the American standard bred as the foundation stock from which we are to evolve this heavy-harness breed. I know that there are people in this audience who will say that it is nonsense to try to produce a coach horse from a trotter. This is quite true, but all standard breds are not trotters. The creation of all new forms is made possible by the occurrence of variation of some degree. This is especially true of the case in point. While as a breed, the standard bred is a speed horse, there are continually appearing in the ranks of the standard bred, horses corresponding much more closely to the heavy-harness than to the speed type. These chance variations are regarded with disfavor by the speed men, for the reason that horses of this conformation and way of going, do not develop the extreme speed desired. There are many instances where horses of this type, after having proved failures as speed performers or sires of speed, have been picked up by buyers, who could see in them an outcome in heavy harness which had been ignored by those who sought speed only. Some of our greatest performers on tanbark, successful in competition with the best representatives of the other heavy-harness breeds have "happened" in this way. The occurrence of the variation which produced them, was altogether an accident and considered as a most undesirable by their breeders. A very meager investigation of the blood lines, from which horses of this type have chanced to be produced, indicates that, while they have been of chance occur-

rence, they have appeared with more regularity in certain families than in others. This should suggest to us, that some systematic effort to bring together those blood lines in which the heavy-harness type has appeared most regularly, could be expected to reproduce the type with a reasonable degree of uniformity. It is an accepted rule in breeding, that, the more closely allied the hereditary forces in two mated individuals (that is, the more proximate their common ancestor), the more uniform the result, while a more radical cross induces greater variation. By the plan just outlined, the breeding operations would all be conducted within the one breed, making possible the closest mating. Consequently, the establishment of a fixed type should not require a great number of generations.

This selection and mating of individuals, of standard breeding only, would seem to be a most logical means of securing prompt and definite results, in case a sufficient number of such individuals could be secured for foundation stock. The difficulty encountered here is largely due to the practice of wealthy exhibitors buying up and either gelding, or withholding from service, horses of this type, which might prove valuable sires were they given the opportunity.

Failing in this, there is left to the American breeder, the alternative of resorting first, to the other native breeds, or second, to the foreign breeds for material with which to supplement the foundation already secured from the standard bred.

In regard to the American saddle horse as a possible source of desirable heavy-harness characters, there appears the same inconsistency as is suggested by advocating the trotter as a possible candidate for heavy harness. As a matter of fact, the advantage to be gained by resorting to this blood, depends altogether upon the judgment of the breeder in making his selections. The saddle-bred horse, like standard bred, possesses certain attributes of distinctive value to his type only. An example of this is his natural aptitude for the saddle gaits. However, there are other characteristics which he has in common with other types, among which are his style, quality, finish, slope of shoulder and pastern, and elastic step; all these he possesses in an extreme degree and to them breeders may look for the improvement of their heavy-harness horses. They should be sought, however, in those individuals which show the least inclination toward the lateral gaits, for any tendency to amble or go anything but a square, straight away trot is most undesirable in the harness horse.

The Morgan has always possessed certain characteristics which are at the present time regarded as most essential in the heavy-harness horse. Their close, full made and smooth turned form, their lofty, toppy carriage of head and tail, bold, trappy way of going, substance and stamina, are all of the greatest value, and supplemented by more size and step, would enable them to conform very closely to the heavy-harness standard. Selected with the same careful judgment, as to type, as recommended in the case of the standard bred, or crossed with any other of the American breeds, or even the Hackney, there

are perhaps as great possibilities for the production of an improved harness horse in the Morgans as in any other American horses.

Notwithstanding the fact, that the standard bred, the saddle horse, and the Morgan, all possess most of the characters, useful in heavy harness, that the thoroughbred, from which they are derived, could be expected to lend, nevertheless there are many individuals, showing a tendency toward grossness, the progeny of which would be benefited, by an infusion of the blood of the thoroughbred. The low, pointing action and erratic temperament, so commonly associated with this horse, however, would be a detriment, should they be bred in a harness horse.

Reference is made to the Arabian blood, in this connection, in recognition of the work of Mr. Randolph Huntington of historic Fleetwood, and of the importations of Oriental horses that have been made into this country. It has been successfully demonstrated, I believe, that even though the Oriental blood has been the original source of all that is good in light horses, it is of little value, at the present time, to increase either running or trotting speed. However, the Arab from time immemorial, has been, in all but size and speed, the truest exponent of equine superiority. The Arabian blood is perhaps of greatest value to us when amalgamated with those native families for which it has the strongest affinity, on account of a common ancestry, more or less remote. The Clay Arabians thus bred, while they have never attained to any great popularity, have certainly produced some individuals, admirably adapted to the production of high-class carriage horses. In marked contrast to the diminutive stature of the purebred Arab, is the size to which many Americo-Arabs develop and breed on. The statement that the desert bred Haleb of Mr. Homer Davenport, most closely resembles the type of the original Justin Morgan, of any horse seen in Vermont, has a striking significance in connection with the known fact that Arabian and Morgan blood nick especially well.

Thus we may very properly consider the standard bred, the American saddle horse, the Morgan, the thoroughbred and the Americo-Arab to constitute the native resources available to the breeders of American heavy-harness horses, and it is only fitting that the United States Department of Agriculture should lead in this work. As you probably know, they have under way in Colorado, an experiment to demonstrate first, the practicability of establishing an American breed of heavy-harness horses and second, the best means to that end. They have placed at the head of their stud an American horse of the heavy-harness type but standard bred and rich in Morgan crosses. The foundation mares are of approved type, of standard and Morgan breeding, with the exception of a few thoroughbreds. Their system, and I believe it is a sound one, is to mingle the blood of all our native horses, then practice a careful selection to type. They have also established in Vermont, a stud of Morgans, with a view to preserving the blood and improving the type, in the line of modern market requirements.

Some men, prompted no doubt, by a spirit of patriotism and pride for American achievements, would limit the breeders of an American harness horse to the so-called native resources only. Others would make use of whatever blood there is available whether of native or foreign breeds. This is a matter for arbitration, although any restriction due to sentiment, is not in accord with the policy which has prevailed during the formative period of most of our established breeds. Since we have drawn on foreign sources in the beginning, there appears no logical reason why such a practice should not be repeated, in case there is any advantage to be derived therefrom. In view of the fact, that there are imported to this country every year, a great number of the best representatives of the carriage breeds of other countries, we would broaden the scope of this subject to include, as material available to American breeders, the English Hackney, the French Coach, and the German Coach—the recognized coach or carriage horses produced in the countries whose names they bear.

The Hackney, undoubtedly, represents more truly, as a breed, the heavy-harness type, than any of the other breeds mentioned. In uniformity of the close, full-made form, and high, balanced action, he is the peer of any horse on the market, and his record in the show ring has demonstrated that fact. In view of this, his American admirers say "you have the Hackney, why endeavor to get any better harness type"? The reason is, that, first of all, we want an American horse. We do not wish to go to England to get our harness horses, when we have the means of producing them here. Furthermore, we have in this country, horses that have time and again shown their superiority to the Hackneys, in American and even in English show rings. This fact leads us to believe, that a little time and systematic effort, will enable us to possess a harness horse unsurpassed by any country on the globe. The Hackney is rich in the possession of one thing which the American heavy-harness horse, as a breed, lacks, i. e., great popularity. Their supporters again come forward with the suggestion "if you will not adopt the Hackney altogether, use them as far as you can in the foundation of your American breed." This, it seems to me, is a rational suggestion. It so happens, that the Hackney excels in those respects in which the American horse is most deficient, viz., uniformity in type, the thickness required of a horse to go in heavy leather, ample bone and substance, and balanced action, flexing his hocks better, as a rule, than the trotting-bred horse. The latter, on the other hand, distinctly outpoints the Hackney in pace, stamina and general breediness. A successful combination of the two, therefore, might give us a horse superior to either. In making such a cross, better results would probably be obtained by using the standard bred as the top cross, since the Hackney has a dash of cold blood, which, experience has shown, should form the base. Nevertheless, the reverse cross is frequently made with very satisfactory results. As a matter of fact, some of the best harness horses in our American markets to-day represent the Trotter-Hackney or

Hackney-Trotter cross. What the second generation of such breeding would bring forth, however, has not been so well demonstrated. Comparison of the ancestry of the two breeds, gives us some reason to believe that the marked variation and difficulty in fixing the type, usually incurred by cross breeding, need not necessarily be expected in this case. The original Shales, founder of the Hackney breed, was by Blaze thoroughbred out of a strong, common Norfolk mare. Also, imported Messenger, the great foundation American sire and progenitor of Hambletonian 10, that greatest source of speed inheritance, is a direct decendant from Blaze through the thoroughbred line. Again, imported Bellfounder, sire of the dam of Hambletonian 10 is but a few generations removed from Shales. This suggests to us the probability of a strong nick when these blood lines are brought together, since they represent affinitive blood centers, the blending of which gives us an harmonious union.

Of all the nations engaged in horse breeding, perhaps none is more systematic and progressive in its policies, than France. Some of the very best individuals seen in the breeding classes of American show rings, are of the French Coach breed. When one considers the number of these horses introduced into this country annually, it leads one to inquire as to the influence which they must have on the American horse stock in general. Their get cannot be said to have been conspicuous in the show ring, a notable exception perhaps being the pair recently sold by Mr. Vanderbilt to King Edward VII. There is some variation in type noticable among horses of this breed, apparently dependent upon the amount of thoroughbred blood which they possess. Those individuals which represent a strong thoroughbred ancestry would, no doubt, prove useful in adding size to our native stock without materially altering its other desirable characters. The French horse, on the other hand, whose cross inheritance is expressed by the term *demi sang*, is of too unstable an hereditary force to be markedly prepotent with other established breeds. The big, coarse, draft coacher, so often incorrectly chosen as the right type by farmer breeders, has too much of the cold blood in his make up to be of any great service in permanently improving our American horses.

The same would apply to the German coach horse, in so far as his lasting influence on our native horses is concerned. He is deficient in hot blood and, while the first cross between the German and American horses, when made to correct the small size, angular form and light bone of the latter, may be perfectly satisfactory, there is some doubt as to the practicability of continuing this cross to successive generations.

Application of the principles of breeding to the conditions, as they present themselves at the present time, leads us to conclude, first, that the breed characteristics of the Morgan are more in accord with the heavy-harness type, with the exception of size and pace, than those of any other American breed or family; second, that many of the individuals of standard breeding but of heavy-harness type which

appear accidental in their origin may be attributed to a certain line of breeding, which, if followed, would give reasonably uniform results; third, that the judicious mating of individuals of this class with Morgans, would, by imparting more size and speed to the progeny than the Morgans possess, together with a more uniformly harness type than the average standard bred shows, offer the greatest possibilities in the establishment of an American heavy-harness breed.

CHAIRMAN GROUT: The next topic is a very important one, an address on "Animal Breeding and Disease," by Dr. A. D. Melvin, Washington, D. C. In the absence of Dr. Melvin, Professor E. C. Schroeder is here and will discuss this question. It is impossible for us to postpone this address, because Dr. Schroeder has to leave to-night. We will now hear from him.

ANIMAL BREEDING AND DISEASE.

By E. C. SCHROEDER, M. D. V., *Superintendent of Experiment Station, Bureau of Animal Industry, Bethesda, Md.*

The subject of the paper or of the material which composes it, was suggested to me by Dr. Melvin, and the paper expresses to a great extent his ideas.

Disease in its relation to animal breeding is a broad subject and presents so many separate topics that an attempt to discuss them all within the limits of a short paper is out of the question, and to make a proper selection is difficult.

All diseases are objectionable to the breeder, not only those with which something of a hereditary character is associated, but also those that are entirely dependent upon, and are induced by, exposure to an adverse pernicious environment. The best results in breeding require the most favorable conditions. Health may be regarded as the first essential of perfection, and everything that either insures or endangers it is of primary importance.

An animal represents a complex group of interrelated physical and chemical processes. Every act or occurrence associated with it, whether normal or abnormal, voluntary or involuntary, is accompanied by positive physical and chemical changes. The relationship of the various organs and structures is so intimate that a superficial knowledge of anatomy and physiology is sufficient to show that no organ or structure can be affected without some influence on the aggregate. The almost universal use of the clinical thermometer by doctors of human and veterinary medicine, to determine the temperature as a first step in the study of symptoms when disease is present or suspected, is based on the intimate connection and association of

everything with everything else in the animal body. In the presence of fever, which is the commonest symptom of disease, the increased temperature exists not alone in the diseased organ or near to it, but in every portion of the organism. The sympathy between the whole and all its parts is so complete and perfect that it has become a fact of general knowledge among practitioners of medicine that even structures in which the circulation is very low or entirely absent, like the hair and nails, may furnish, by their varying character, both an index of the immediate bodily state and a record of what it has been for some time past.

With these facts in mind the breeder need not be told that the presence of any disease is a disqualifying condition in an animal from which the largest profit or the highest type of progeny is expected, and that animals affected, especially with chronic diseases, should invariably be condemned for breeding purposes until they have been restored to health.

When sheep and cattle, for example, are affected with scabies, it is something more than the wool and the skin that suffers. The drain on the whole system; the absorption of noxious material from the injured skin; the constant itching discomfort caused by the scab mite, to say nothing of the danger that the disease will be transferred directly by contact from the parent to the offspring, are conditions that must be taken into consideration, because they combine to narrow the margin between the cost of production and market value. It is the realization of this fact that is behind the investigations of the Bureau of Animal Industry to discover the best and most economical remedy for scabies.

The same is true of most diseases and parasites with which animals are affected and adverse conditions to which they are exposed. The losses caused by the cattle tick in the Southern States are so great that an attempt to state the amount in figures would be equivalent to inviting criticism for exaggeration; and if it were possible to determine the total value destroyed by internal and external parasites—a large percentage of which can, and should eventually be saved by a proper co-operation between the breeders of animals, the National Bureau of Animal Industry, and other establishments for the investigation of animal diseases—a loss would be shown that is incredibly great.

A parasite does not confine its activity to feeding at the expense of its host. With some parasites, like the bacteria that cause infectious diseases, the injurious effect on the host is so apparent that in comparison the nourishment abstracted is lost sight of or is entirely ignored. With the larger parasites the injury done in addition to the absorption of food is not so apparent, but it is for that reason none the less real, as anyone can testify who has made careful post-mortem examinations of young animals, especially lambs and pigs, and has frequently found no other cause for death than stomachs, intestines, lungs, or livers crowded with worms.

In its effects on the profits of the owner, the presence of parasites in or on the body of an animal may be compared to a leak from a barrel of valuable fluid. A light infestation, like a small leak, represents a small loss; an excessive infestation, like a leak that shortly drains the barrel, means rapid and great loss. But the comparison is not perfect; there is this difference: In the case of the barrel the leak is not communicated to other barrels, while the presence of parasites in one animal is the certain means of their introduction into other animals.

Facts of this kind are so generally known that it seems hardly necessary to restate them, until we inquire about their practical application for the improvement of the animal industry of the country and hence for the insurance and increase of the profits derived from it.

If the knowledge we have of infestation with parasites and infectious diseases was as generally applied as it should be, we would not long remain in a position to regret that an infectious disease like tuberculosis, that is strictly preventable, should be common even in herds of purebred cattle. How common it is was illustrated recently by a well-known breeder who undertook to gather a lot of purebred cattle for shipment to Argentina, and found, on applying the tuberculin test, that 50 per cent of those selected reacted because they were affected with tuberculosis. Cattle from the United States are n t eligible for shipment for breeding purposes to Argentina, Canada, Uruguay, and Japan until they have withstood the tuberculin test. Great Britain admits our cattle and sheep only for slaughter within ten days after arrival, at the docks where they are landed; and most European countries practically exclude our cattle and other live-stock. The reason given for these restrictions on our export trade is the existence of contagious diseases among our animals, and before the restrictions are removed it will be necessary to eradicate the diseases and demonstrate to foreign countries that they risk nothing by exposing their animals to ours.

Breeders of cattle whose herds are affected with tuberculosis should adopt some system of management that will eventually eliminate the disease. A system that was practiced at the Bureau of Animal Industry Experiment Station, when some of the cattle were found about nine years ago to be tuberculous, proved both economical and successful. All the cattle were tested with tuberculin, and those that reacted were immediately separated from those that did not react. The healthy cattle were placed in stables that had recently been disinfected with a solution of corrosive sublimate—one part of sublimate to 750 of water—and were afterwards kept strictly separated from all tuberculous cattle and all cattle that had not successfully passed a tuberculin test. Whenever additional animals were purchased they were placed in a separate special inclosure or stable, and tested with tuberculin before they were allowed to come in contact with the non-tuberculous cattle. Tuberculin tests of the non-affected cattle were made

about every six months, and in eight years only one case of tuberculosis developed in the herd that numbered at different times from 25 to 100 individuals. The one case was a bull that was occasionally used to serve tuberculous cows; and he illustrates rather how slight an exposure is sufficient to transmit tuberculosis from animal to animal than any failure in this system of cleaning a herd and protecting it afterwards against the introduction of infection. Calves produced by the tuberculous cows were left with their mothers until they were ready to wean, and then placed in a separate pen for a period of from 45 to 90 days before they were tested with tuberculin, and, if they failed to react—which was the rule rather than the exception—they were treated as healthy stock, and afterwards invariably remained free from tuberculosis. The period allowed to elapse after removal from an infected environment before making the tuberculin test is believed to be necessary, because it has been shown at the Station that animals tested directly or shortly after removal from exposure to tuberculosis may fail to react, but when retested several weeks later occasionally react and are then found to be affected.

The freedom from infection of the calves produced and suckled by the tuberculous cows is somewhat surprising. It may be explained on the basis of insusceptibility during the period when the young animals live exclusively on an animal diet (the milk of their mothers), or to the fact that tubercle bacilli are rarely secreted with milk in the absence of udder disease. The question is one that cannot be discussed at greater length at the present time.

This work was done on a farm, the total area of which during the greater part of the time was less than 20 and never more than 50 acres, and on which, during the whole time, a large number of animals affected with tuberculosis contracted naturally, and with tuberculosis intentionally induced for purposes of investigation, were kept.

There are no valid reasons why a similar system for freeing their herds from tuberculosis should not be attempted by all breeders of cattle who have sustained losses through this affection, even if they are opposed to undertaking more strenuous means. If breeders insisted simply that all animals bought for introduction into their herds should be purchased subject to the tuberculin test, I am convinced that it would improve the condition relative to tuberculosis in a short time to a surprising extent.

It must be borne in mind here, too, that tuberculosis is an insidious, chronic affection, which, if it has once presented itself and nothing is done to check it, will cause ever-increasing losses that must ultimately lead to bankruptcy. It is strictly progressive, absolutely sure, and will not die out unless it is opposed; it is not like the acute affections that run a rapid course, cause great destruction and loss, and then disappear, or like some parasitic conditions that are responsible for a constant but not greatly varying or increasing leakage of profit.

Tuberculosis has also an important significance in connection with hog breeding, as hogs and cattle are exposed to each other in many

ways, and both species are susceptible to the affection. It is being reported among hogs with an increased frequency that is alarming, and among them is commonly a more acute disease and becomes more rapidly generalized. The packers are becoming alarmed at the large number of condemnations of hogs for tuberculosis in the meat-inspection service. There are satisfactory reasons for believing that its existence among hogs is almost if not entirely due to their direct and indirect exposure to tuberculous cattle, and that its elimination from cattle will speedily be followed by its disappearance among hogs.

There is a matter to which Doctor Melvin, Chief of the Bureau of Animal Industry, requested me to call special attention. Heretofore at shows each breeder has exhibited his animals together, keeping them separate from other animals. Recently the English custom of having all animals in each class exhibited and stalled together has been quite largely adopted. This method of stabling by classes instead of by owners is one of the best imaginable ways for spreading disease. An illustration of the results of the practice is afforded by Guernsey cattle from the Island of Guernsey, where tuberculosis did not formerly exist, having developed tuberculosis by being shown at English fairs, where they were stabled with English cattle, among which tuberculosis is quite common.

This method of exhibition should be emphatically discouraged and condemned, because it is not only the communication of tuberculosis that is to be feared, but likewise the communication of other infectious diseases and parasitic conditions. The greater ease with which different animals of the same class can be compared is not a sufficient advantage to compensate for the dangers that underlie the miscellaneous exposure of the individuals from different herds to each other.

Relative to the tuberculosis among the cattle of Great Britain and the Channel Islands, the following record is interesting: In the years 1901 and 1902 the United States Department of Agriculture tested 377 Guernsey and Jersey cattle on the Islands, and out of the lot only one showed a temperature reaction indicative of tuberculosis. This is less than one-third of 1 per cent. As the animal that seemed to react was not killed and examined post-mortem, it cannot be asserted that it was actually affected. In contrast, among 99 Guernsey and Jersey cattle tested by the Department during the same years in England, 30 reactions were obtained, indicating that nearly one-third of the same breeds of cattle that are free from tuberculosis in their native islands are affected in England. The amount of tuberculosis among 1278 cattle of all breeds tested in England and Ireland by the United States Department of Agriculture in the years 1901 and 1902 was 17.92 per cent. The extent to which English herds are diseased varies greatly with different breeds. It has already been pointed out that nearly 30 per cent of the English Guernseys and Jerseys are tuberculous. Our inspector found that the percentage in 1901 and 1902 for Shorthorns was 23¼, and this figure is borne out by that obtained by the Canadian inspector in Great Britain, whose figure for Shorthorns was 23 per

cent. These percentages, it should be borne in mind, were obtained with cattle offered for export to the United States and Canada, and show that it is necessary to insist that cattle should be required to pass the tuberculin test before they are allowed to enter this country.

The condition in some herds in England early in 1902 was found to be so bad that Doctor Salmon, at that time Chief of the Bureau of Animal Industry, issued instructions to the United States inspector in Great Britain not to test cattle intended for shipment to this country from a number of badly diseased herds until they had been cleaned. The English method of exhibiting cattle at shows is undoubtedly responsible in a great measure for the extensive infection of English herds. This, and the movement of cattle from herd to herd without first subjecting them to a tuberculin test, are among the most important factors in the dissemination of tuberculosis among cattle.

Right here it may be advisable to say a few words about our national quarantine regulations. The need of stringent regulations to protect our animal industry and the breeders of animals against loss is only too well shown by the history of contagious pleuro-pneumonia and foot-and-mouth disease, that were effectually stamped out after their introduction, but at a great expense and after having caused enormous losses. It does not seem to be clear in the minds of some breeders that the harm done by infectious and contagious diseases is very much alike irrespective of their acute or chronic character, and hence there has been some opposition to the regulations regarding tuberculosis and the application of the tuberculin test. The difference between tuberculosis and a more acute affection like contagious pleuro-pneumonia is due mainly to the fact that the one reaches a certain end slowly, gradually, insidiously, and the other rapidly and visibly. If no measures were taken against the spread of tuberculosis and to prevent its importation from foreign countries, it would still require some time before the utter ruin of our cattle industry was completed, but the end would as certainly be ruin as with other more acute affections were they allowed to operate and spread without restraint.

There is one condition that our quarantine regulations effect that is little thought of. When we quarantine against certain diseases that are prevalent in the countries from which we import animals for breeding purposes, we are strictly practicing a system of selection, and the character selected is disease resistance. Where the importations are so small, a percentage of the stock already in the country, as in our case, this selection of disease resistance will produce results of insufficient magnitude to be a determinable quantity, unless it is after a very long time. But there is a practical side to it; it points the way for the breeder to follow. If he should apply the same tests to every new animal introduced into his herd or flock that are required by the Federal Government before animals can enter the country, we would soon have established a system of selecting disease-resistant animals that would bear rich fruit. It requires the co-operation of many men to produce great results, and it is hoped that many men, breeders of

purebred as well as of other stock, if they are not now practicing a system of selection like that here indicated, will lend their aid by adopting *some* system at once, both for the general good of American animal industry and because it will protect their immediate interests.

The term selection suggests the relation of heredity to disease. When we examine the views expressed by writers on the subject of inheritance, we find that they range from the conviction that all diseases are to some extent heritable, to the belief that all diseases are the result of exposure to environment. It is not intended in this paper to favor one extreme or the other, or to draw a line between the two; but I wish to call attention to something that is intimately associated with disease that is certainly transmitted by organisms to their progeny, namely, susceptibility to disease.

Susceptibility means simply that an animal is liable to contract certain diseases or to harbor certain parasites when it is subjected to a certain environment. When hogs are exposed to hog cholera they almost invariably become affected; the same exposure means nothing to cattle. If the exposure is to blackleg or Texas fever the cattle suffer and the hogs are not endangered. Hence, hogs are susceptible to hog cholera and cattle to Texas fever and blackleg; and this susceptibility of the hogs to the one affection, and of the cattle to the other two, is so nearly a uniform condition with all the individuals of each species that no explanation is conceivable which does not recognize it as a specific hereditary character. A hog naturally insusceptible to hog cholera or a cow to Texas fever is no less remarkable than an organism that varies greatly from its progenitors and other individuals of its species in some superficially visible manner; and a hog susceptible to Texas fever or a cow to hog cholera, in the light of our present knowledge, would be a surprising sport. This susceptibility for certain diseases and parasites is hence remarkably specialized. Just as hog cholera and several other hog infections are hog specialties, so also are hog lice and several other hog parasites hog specialties; and this holds true with the diseases and parasites of horses, cattle, sheep, poultry, etc.

The specific susceptibility of animals to diseases and parasitic conditions has received too little attention in selective breeding. It is a varying character and therefore should be capable of modification by selection like other varying characters, though its selection offers some difficulties, as it frequently involves the destruction of a large number of animals in a way that makes their bodies unfit for food and most other economic purposes. But the question has sides that should receive attention and could be attended to without much loss or trouble. For example, the degree of susceptibility to harbor intestinal parasites could be determined by macroscopic and simple microscopic examinations of feces, and only those animals used for breeding that show the greatest freedom from such parasites.

At the Experiment Station of the Bureau of Animal Industry the susceptibility of many hogs to hog cholera has been tested during the

last ten years in connection with the regular, systematic investigations of hog diseases, and it has been discovered that it varies from extremely high susceptibility to absolute immunity. A similar variation in the susceptibility of animals to parasites peculiar to their species has also been observed. Among hogs approximately 1 per cent are immune from cholera. The difference in susceptibility of cattle to Texas fever varies so much that some cattle suffer only a very mild, barely determinable attack from the same exposure that is rapidly fatal to other cattle; and this difference of susceptibility was found to be independent of visible vigor, or lack of it, in the exposed animals. The same statement can be made regarding blackleg and tuberculosis, and probably, if our experience were more general, could be made of the whole category of infectious diseases.

Among cattle one cow was actually found on which cattle ticks would not grow, and several cows on which they grew only sparingly under conditions that caused extreme infestation of other similarly exposed cattle. This is all the more remarkable, as cattle are not the exclusive, but only the greatly preferred host of cattle ticks.

The efforts made at the Bureau Experiment Station to grow hogs immune against hog cholera by breeding artificially immunized hogs ended in absolute failure. The progeny of the immunized hogs showed no modification or reduction of susceptibility. The work recently begun to obtain a breed of immune hogs by breeding from naturally immune stock has not progressed far enough to justify drawing conclusions. One litter of five pigs produced by a naturally immune sow with a naturally immune boar were tested and found to be immune; a second litter of five pigs produced by the same sow and boar when they were exposed to infection all contracted cholera and died.

An attempt to produce an immune race or breed of hogs by selecting naturally immune animals seems more promising than the selection of artificially immunized animals, because there are many reasons for believing that so-called natural or spontaneous variations are more freely transmitted by heredity than induced modifications. Work is also in progress in co-operation between the Animal Husbandry Office of the Bureau and the Rhode Island Experiment Station at Kingston, to breed, if possible, a race of turkeys immune to infectious enterohepatitis, a disease more commonly known as "blackhead," that is a serious drawback to the turkey industry in the East.

Recently extensive investigations have been started by the Bureau to gain additional information on many other phenomena of special interest to breeders of animals. An attempt is being made to solve some of the complex problems of heredity; to determine how the Mendelian Law of Heredity applies to animals; to learn the true significance of inbreeding; to discover the hereditary value of functionally acquired modifications, etc.

The establishment of immune breeds of animals will be a slow process; it will be a long time, if success finally rewards our efforts, before practical benefit can be derived from it by breeders and con-

sumers of animals. For the present we should make every effort to free our herds and flocks from disease, and, once we have them free, to keep them so. What has been said about tuberculosis is an illustration of what can be done, at no great expense. One breeder has expressed his intention to establish a herd of purebred cattle free from tuberculosis, and to advertise it extensively as such. Experiments are now in progress to determine the precautions to be taken to raise lambs free from parasites. The precautions, until a worm-free flock of sheep has been established, will require thought, labor, and expense; but once such a flock has been established, the increased profits it will yield in finer, more rapidly developing animals will prove a very satisfactory compensation for the price paid to get it.

Sooner or later measures will be adopted by the purchasers of livestock, for slaughter or other purposes, to trace diseased animals to their former owners, and to make them responsible for the loss they represent. The matter is being agitated now. At present the larger purchasers, the large butchering and meat-packing establishments, seemingly lose when animals are condemned after purchase either before or after slaughter, but this is only a fiction. The loss is now divided either among all the breeders and feeders who have animals to sell, or among the consumers of animal products, as no great business establishment would fail to take into account its probable losses from definite causes like an inspector's condemnation of diseased or unfit carcasses. This loss is carefully calculated, and a correspondingly lower price given for all animals offered for sale by breeders and feeders, or a correspondingly higher price exacted from the consumer, or perhaps both. When means are adopted to make each man responsible for the loss due to disease among the animals he sells, the breeder who has not prepared himself to meet the new conditions will be in an unenviable position.

The Bureau of Animal Industry can do and is doing much, but the bulk of its work for the benefit of the animal breeder and feeder now is, and always must remain, that of an agent for devising, discovering, and suggesting means for increased safety and general improvement. It is hoped that the Bureau will have the hearty co-operation in its work of all breeders of animals, and through them the co-operation of the States, because their support and co-operation is needed in order that it may serve them especially, and the public generally, to the best advantage.

After announcement by Professor Hays with respect to obtaining copies of past proceedings of the Association, on motion the section adjourned until 10 o'clock a. m., Wednesday, January 16, but announcement was made of a joint session at 8 o'clock p. m. at the Board of Trade Auditorium.

TUESDAY AFTERNOON, JANUARY 15—SESSION OF THE PLANT SECTION.

The Plant Section met in Chemical Hall, in connection with the Ohio State Farmers' Institute.

The following papers were presented and discussed at the afternoon session of the Plant Section. Interesting discussions[1] were had at all sessions of the section.

SOME RESULTS IN SELECTING RED CLOVER FOR DISEASE RESISTANCE.

By SAMUEL M. BAIN and SAMUEL H. ESSARY, *Knoxville, Tenn.*

This paper, which is published in full in Bulletin No. 75 of the Tennessee Experiment Station (co-operating with the Plant Breeding Investigations of the U. S. Department of Agriculture), gives the results of an apparently successful effort to produce an anthracnose-resistant strain of clover. The authors began about two years ago an investigation into the cause of the extensive failure of clover in Tennessee in recent years, and soon reached the conclusion that a hitherto undescribed fungous disease is chiefly responsible for the trouble. To the fungus was assigned the name *Colletotrichum trifolii.*

In the late summer and autumn of 1905 about 200 selections were made of healthy clover plants growing surrounded by masses of plants killed by the disease. These selections were made at various points at an extreme distance apart of some 400 miles. In the spring of 1906 these select seed were planted in rows 18 inches apart alternating with other rows planted with non-selected seed. Dead clover, raked up from a near-by clover field, where the crop was killed by the disease in the previous season, was scattered over the plants in the entire plat. Although a large part of the young clover in the plat was destroyed by the clover weevil while the plants were in the seedling stage, enough rows were left at one end to make a satisfactory test.

By June 20, a remarkable contrast was evident between the select and the non-select rows, the former being green and healthy, while the latter were blackened and dying. The dead non-select plants bearing myriads of spores were removed and scattered over the select plants so as to test thoroughly their power of resistance. Although ordinary plants at this season of the year will die within nine days after having spores sprayed upon them, very few of the select plants

[1] As no reporter could be secured for these meetings, the Secretary regrets his inability to present these discussions to members receiving Volume III. Provision will be made at future meetings to secure the discussions at all sessions.

died of the disease. The select plants made a good crop of hay and produced a normal crop of seed, though in many cases traces of the disease were present. In many of the select plants not a trace of the disease was to be seen.

A most conservative estimate, made late in the following winter, places the odds in favor of the plants selected for non-resistance at 50 to 1.

IMPORTANCE OF THE MUTATION THEORY IN PRACTICAL BREEDING.

By GEORGE HARRISON SHULL, *Cold Spring Harbor, N. Y.*

The time is long past when the practical man who is looking for immediate economic values is inclined to ignore the work done by the devotee of pure science. Conversely, the scientist appreciates as never before, the reciprocal relation existing between his work and that of the man who would turn every available resource to the production of something useful to man.

Nowhere is this improved relation between the theoretical and the practical better exemplified to-day than among breeders, and the establishment of the American Breeders' Association is a noteworthy indication of the existence of this improved condition. At the same time this organization fosters and promotes the reciprocity that shall increase the volume and the value of both scientific and economic breeding.

It is now a truism that all economic breeding must be in as great degree as possible scientific, and that all scientific breeding is likely to prove in the long run economic. Much of the scientific work being done, seems rather remotely if at all economic, and it is not always easy to indicate wherein any specific result is of practical value. Experience has shown, however, that all science is so closely and so complexly interrelated, that few scientific researches are conducted, whose economic bearings do not sooner or later become manifest, though their true economic worth may not be recognized for years.

While it is not fair to the scientist to insist that he shall be able to point out the economic value of all of his results—in the search for truth he must not be so hampered—it is fair to ask of science that, when any of its results have a large and important bearing upon economic problems, these results shall be made as available as possible for the use of those who can turn them to immediate practical account.

The mutation theory, formulated by de Vries and supported by a great mass of data which he had gathered during twenty years of careful and energetic work, has this large bearing. It struck a fundamental key in biological science, and is now one of the principal foci about which biological research and controversy are centering. Almost daily some new scientific support for the theory is given from

experimental sources, while with similar frequency controversial papers unsupported by experimental evidence, are being directed against it. Under these conditions it is not difficult to foresee the outcome. In science, truth will prevail, and the accumulation of experimental data can never be overthrown by volumes of speculative character with whatever of warmth or asperity they may be written. The fact that the mutation theory is a subject of controversy need not concern us here, however, since even its most strenuous opponents grant that it is supported by garden experience. As the practical breeder is little concerned with what goes on outside of field and garden cultures, there can be no controversy regarding the truth of the mutation theory in its applicability to economic breeding.

The central doctrine of the mutation theory, is the origin of new forms—whether we call them species, elementary species, varieties, or strains—by the sudden appearance of an aberrant specimen that gives rise at once to the new strain by producing offspring like itself. The alternative conception is that usually attributed to Darwin, in which new hereditary lines are established by the gradual cumulative action of the environment in selecting those slight variants which are best qualified to meet the conditions under which they must live.

Every breeder is familiar with the large number of unexpected variations or sports that have been the starting points for new strains both in plants and in animals; and the value of these sports to the breeder is too well understood to need comment. It should be said, however, that there is grave danger of ruining the reputation of the words "mutant" and "mutation," and I earnestly ask your assistance to prevent this. Certainly not every aberrant form we see is a mutant, and when plants are capable of propagation by some vegetative means, as by bulbs, tubers, buds, cuttings, grafts, etc., many striking individual variations may be preserved and extensively multiplied, which are not mutations at all. No combination of characters resulting from the resolution and recombination of the parental qualities in hybrids ought ever to be called a mutant, however striking or unexpected it may be, because in these cases no really new quality has been produced, but only new combinations of qualities already in existence. Mutations can only be recognized as such with certainty when they arise in pure-bred strains. They are not to be distinguished from fluctuations by being large and striking variations but by the fact that they represent a fundamental change in the internal composition or structure of the vital substance, which renders the characteristic qualities of the new form transmissible through sexually produced seeds. Variations that are thus transmitted are often very insignificant, quantitatively, compared with others that are not so transmitted. We must be careful, therefore, not to handle the word "mutation" too lightly, since we can know that a plant is a mutant only after a sufficient number of seed generations have been produced to demonstrate the permanent character of the variation.

Many economic varieties are the result of hybridizing natural species, and this is especially true of perennials, which possess means

of vegetative reproduction, but the number which are the result of mutations and of the crossing of the products of mutations which have arisen in gardens, is enormous. If the mutation theory holds for plants and animals in a state of nature, and this appears daily the more probable, then mutation is the basis for the origin of every permanent variety or strain. In nature, mutations have been preserved because they were adapted to the life conditions in which they originated; in the garden they have been preserved because they pleased the eye of man or promised to minister to his wants or needs.

As a typical instance of the utilization of mutations in the production of valuable modifications in an otherwise comparatively worthless plant, take the little red poppy of the English cornfields, known to the botanist as *Papaver rhœas*. Until 1882 this plant had received little attention from the horticulturist. Few and slight variations had doubtless been observed, but the form, size, and color of the flowers were fairly constant as still seen to-day in the uncultivated specimens growing abundantly as weeds in the English fields. A quarter of a century ago a mutational change in the color of the flowers of one of these little poppies attracted the notice of Rev. W. Wilks, the present secretary of the Royal Horticultural Society. He removed the plant to his garden and raised numerous seedlings from it. Without crossing with any other species he developed in a very few years the beautiful Shirley poppy with all its numerous color variations, ranging from the intense red with a black cross in the center as seen in the original wild form, through shades of red and pink to salmon and white and nearly sky-blue with a white or black cross, or a black cross margined with white, or no cross at all, with the petals margined with red, white, or blue, and often with the most delicate shadings, veinings and stripings. Owing to the methods used in the development of the Shirley poppy, many of the steps are not as well known as would be desirable, but the fact that none of the new qualities were brought in by hybridization leaves all to be explained by mutation.

Other equally impressive examples of the myriad forms that may arise in this way are seen in stocks, sweetpeas, and garden beans, and out of your own knowledge you may add many more quite as typical. These instances are typical of all the familiar cases not only in that they represent the production of numerous new constant forms without hybridization, but also because they agree with the general experience that the sports that have been used as the starting points of new strains have been those that had to do with some large and striking character, such as color of the flowers, cut or color of the leaves, habit of branching, etc. In other words, these striking variations have been observed and utilized in the formation of new strains not so much because they were sought for and found, but because they could not be overlooked.

In all such cases the individual plants stand out with such prominence that seed of the mutant is likely to be saved apart from the seeds of the parental form, thus leading to its rapid segregation. Some recent results of breeding show that mutation is just as preva-

lent in grasses and grains as in flowers, but they have not been noticed generally because the external characters which distinguish each newly arisen form from its parent, will be observed in most cases only upon careful examination by a trained eye. Yet the value of these mutations in the field crops is economically greater than that of the striking changes that have added to the attractiveness of our flower-gardens, because, however small or insignificant may be the external characters by which the several mutants of grass or grain may be recognized, each elementary form has its own characteristic size, shape, weight, number, and nutritive value of the seeds, adaptability to particular climatic conditions, resistance to disease, or the attacks of insects, etc.; and some of these new forms are sure to prove distinctly better in some or all of these respects, than those already in cultivation.

This emphasizes one of the most important gains that come to plant breeding through the recognition of the mutation theory. When sports or mutants are recognized as normal products of a natural process, the eye of the breeder learns to seek for mutational variations, and this search must result in the discovery of many instances of mutation of lesser magnitude—though possibly of even greater economic value—than was formerly required to force themselves upon his attention. He will also look for mutations in plants whose individual characters had before passed almost unnoticed. It is plain, therefore, that the greatest advance to result from the mutation theory will be made in the breeding of those economic plants in which the individual loses itself to a great extent in the population, as is the case in the field crops, for in these it indicates the desirability of handling the individual in much the same manner as it would be handled in the development of a new variety of flowers.

In the various grass, grain, clover, cotton, and other field crops that are raised from seed, most of the work of improvement has been carried forward thus far on the basis of mass-selection instead of individual selection, the chief incentive to this method being the general belief in the injurious effects of in-breeding. Many excellent gains have been made by this method, but it is now obvious that it is not calculated to produce either the best attainable result or the largest return for a given expenditure of energy, and these are the prime economic considerations. Rimpau required twenty years for the isolation of the famous Schlaustedt barley which has added so largely to the value of the German barley crop, and this length of time was consumed because he did not realize that his problem was one of isolation instead of fixation. It is probable that the use of some good isolation method would have accomplished an equal result in one-fourth the time.

Every method which carefully tests the transmissible characteristics of the *individual,* and bases its selections upon performance records is in essential harmony with the conception that each economic variety is a composite group of distinct elementary forms that have origi-

nated and do originate one from another by mutation. Several such methods have already been devised and their value is becoming daily more appreciated. One of the earliest of these isolation methods was that used by Vilmorin in the improvement of the sugar beet. It is known as "Vilmorin's Isolation Principle," and consisted as applied to beet culture, in the growing of the offspring of individual seed plants in parallel rows—one row from each parent—and the use of a portion of each row in determining the percentage of sugar of the particular hereditary line to which that row belonged. Seed plants for the next year's crop were then selected from the rows showing the best performance record, *i. e.*, the highest sugar content associated with other desirable qualities. Johannsen has demonstrated that this method is fundamental in the improvement of beans by selection, since what appeared to be a homogeneous variety possessing only fluctuating variations was found capable of being at once separated into a number of distinct hereditary lines each with its own characteristic size, form, and weight of seed, width of hull, etc. The ear-row test is essentially the same method applied to the breeding of corn.

"The centgener method," designed by Mr. Hays for use in grain-breeding experiments at the Minnesota State Experiment Station, is one of the best and most complete isolation methods yet devised, and the splendid results in the immediate discovery of several wheats of surpassing merit have brought the method into deserved prominence.

To still another agricultural genius is due the credit of having worked out an isolation method in the breeding of economic seed crops, and of having achieved noteworthy results quite independently of the mutation theory, but his method like those already mentioned owes its preeminent success to its accord with that theory. This man is Dr. Hjalmar Nilsson, Director of the Swedish Agricultural Station at Svalöf. Dr. Nilsson has doubtless had from the first a clearer conception than had any one else, of the true constitution of the economic crops, for within a year after he was made Director of the Svalöf Station in 1890, he had recognized the composite character of the several named horticultural and agricultural varieties, and had decided that the elementary species is the unit with which the economic breeder must deal. Up to that time the work of the Swedish Station had consisted largely in the testing of named varieties, each variety being accepted as a horticultural unit; but, upon the adoption of the new point of view, the director and his corps of assistants set to work to separate the elementary forms making up the several varieties, and to study and tabulate their characteristic differences. They found that every elementary species has its own normal mean condition of its several morphological and physiological features including all those characters which determine the success or the failure of an economic crop. In the fifteen years during which this discovery has formed the basis of operations at Svalöf, that station has become famous for its achievements, despite the fact that all of its publications have been

rendered nearly inaccessible to the breeders of other countries by being printed exclusively in the Swedish language.

In the last five or six years, careful pedigreed cultures of a large number of these isolated elementary forms have been made at Svalöf, and a number of mutants have been seen to originate in purebred, carefully guarded lines, so that there can be no doubt that the elementary species of the various grains are the products of mutuation either directly or through the combination and resolution of the characters of two or more other elementary species by means of hybridization. Indeed, every logical consideration as well as all the experimental data now available lead conclusively to the view that the very existence of distinct elementary species differing from each other by unit characters is indubitable evidence that they originated by mutation.

In discussing the importance of the mutation theory, it is not to be forgotten that mutation and Mendelism are counterparts of each other and both depend for their validity, upon the existence of unit characters. These three—mutation, Mendelism, and unit characters—are all part and parcel of one consistent view of the world of living matter. Together they constitute the new biological knowledge which has revolutionized the discussion of breeding problems, and which has already entered in large measure into the methods employed by the breeder. Of the supreme importance of this new discipline as a whole nothing need be said, and it would be futile to attempt to dissociate the theory of mutation from the conception of unit characters and Mendelian inheritance in order to weigh the importance each would have for practical breeding when standing alone. Neither Mendelian inheritance nor the mutation theory could have assumed by itself the sudden importance they have now attained; but the appearance of both at the same time, both telling the same story of the existence of character-determining units, have wrought so great a change in biological thought as to amount practically to a revolution.

Always in revolutionary times the sane, conservative man guards himself against being carried too far afield, and it may not be out of place to say here, that although we must recognize the great value of the new theories, *they are not everything* that the breeder needs to keep in mind. There are many characters that are not unit characters, variations that are not mutations, and inheritance that is non-Mendelian, and such characters, such variations, and such inheritance are also important to the breeder. Indeed, another great advantage the breeder gains through recognition of the mutation theory comes from the strong emphasis that theory places upon the fact that variations are not all alike. A sharp distinction is drawn between mutations and fluctuations and the breeder who would derive the greatest possible benefit from the mutation theory will carefully keep this distinction in mind to serve as a guide to the technique that may be expected to best meet the requirements of each particular case.

In the selection of a permanent seed-strain, mutation must be the

basis either directly or indirectly, but many elementary forms have a wide range of fluctuating variability and there is in such cases the capacity for great improvement within the elementary species. In the improvement of strains by the selection of the best fluctuating variants, however, unceasing attention is necessary: for the possibility of fixing an extreme of the fluctuating kind lacks experimental support. No matter how long the selection of the same extreme is carried on, the instant the selection ceases to counteract the regression, a deterioration begins, and in the course of time there is a complete return to the norm of the particular species or strain in question. When a new elementary species originates by mutation, a new norm is produced and if this is a higher norm with respect to the aggregate of economic features than that possessed by the parental strain, a distinct and permanent advance has been achieved. A new range of fluctuating variability has also been produced and if this range is greater than that of the parent, new possibilities of improvement within the elementary species is provided for.

It has been found that mutants arise in a species with something like a constant frequency and that the economical way to secure mutants is to raise enormous numbers of seedlings among which to search for them. It is confidently expected that at some not distant time, ways will be found to increase the relative number of mutants, or even to influence the direction of mutation. A first important step has been made in this direction by Dr. D. T. MacDougal, the Director of the Department of Botanical Research of the Carnegie Institution at Washington, who has apparently induced mutations in several species by injecting into the developing ovaries various solutions of mineral and organic substances, but aside from the suggestion offered by these interesting experiments, we seem to be at present entirely at the mercy of nature. However, nature treats us well if we stand equipped with as complete understanding of her ways as science provides, ready to take advantage of and preserve every advance she makes.

In summing up, it may be said that the value of the mutation theory in its bearing upon practical breeding lies in the better appreciation it gives of the significance of the phenomena with which the breeder must deal. New methods and the extension of old methods to new material are indicated, the characteristic features of the method being the production of enormous numbers from which to select, the complete isolation of each individual whose characters suggest the possibility that it may be the starting point of a new strain, the complete control of the fertilization processes, and the rearing of the offspring of the guarded plants under conditions that will allow all distinguishing characteristics to reach a normal development.

But even if no changes in method were suggested—if old methods adopted empirically should be found to harmonize perfectly with the theory so that no improvement could be made—the value of the mutation theory is great in the feeling it gives the breeder that he

is handling the normal and eternal forces of nature. An added interest attaches to each new variation when it is realized that every instance of mutation is a part of the order or nature, and not a monstrous departure from natural conditions; and the sense of exaltation that comes from dealing with the processes and products of universal evolution cannot fail to increase enthusiasm and efficiency in the breeder's work.

CARNATION BREEDING.

By FRED. DORNER, SR., *Lafayette, Ind.*

Carnation breeding, as it is carried on among the florists at the present time, is altogether for commercial purposes. Its object is the production of new varieties which are improvements over existing forms. The gradual deterioration of the standard varieties has naturally increased the demand for others to replace them. The greater prevalence of disease among carnations at the present time, has also caused a demand for disease-resistant varieties.

As the carnation is a plant which has been under cultivation for centuries, it is necessary to know something of its primitive characters to understand the significance of its development.

The original carnation, as we are told, was a small single flower of a flesh or pinkish mauve color. The more one studies the carnation of to-day, the more one is inclined to believe that the latter was the more common color, as a mauve or purplish color may be detected in most varieties of to-day. It bloomed but for a short season each year and was of a very grassy habit.

The first noticeable improvement was probably made, through breeding and cultivation in France during the sixteenth century. However, it was not until the year 1840 that our present monthly and, later, everblooming variety made its appearance. This also occurred in France.

The most noticeable improvement in this type came 30 or 40 years later in this country. To-day its culture has been taken up by many specialists and it is a staple product with most florists.

Judging from the present achievements, the result of this development from its original state is due to accidental and artificial breeding and cultivation. Cultivation gave us the double flower, but it required the aid of breeding to give color, size, and longer and stronger stems. To this it also added a more desirable habit and freedom of bloom. These latter qualities have given us our present ever-blooming varieties.

A third factor, for the improvement of a race, is selection. By its aid a variety may be raised to a much higher standard. Selection is naturally used in breeding on the ground of the "survival of the fittest."

This now brings us to our present methods of cross breeding.

The first thing to be considered is the elimination of many of the objectionable characters which belong to the primitive form, and which cling very tenaciously to the race. In addition to these are other characters incorporated during later stages of development which must also be eliminated. It is these undesirable habits which retard the work and make progress slow.

The tendency to revert is very great. Favorable cultural conditions, in connection with careful selection in breeding, help much to eliminate undesirable characters. A neglect of these two factors will encourage reversion. The natural laws of reproduction are too strong to eliminate at once all the objectionable hereditary traits.

This is well illustrated by the results of carnation breeding at our own place. The work was begun in 1889 and the varieties used were those then at my command. They comprised all the principal colors. For two or three years all new varieties obtainable were also added to the stock. After this time the work was confined mainly to the seedling stock which from year to year developed better qualities.

The tendency to revert is well shown here. In the first lot of seedlings fully 50 per cent were single; 15 per cent had split calyces; 20 per cent were croppers or annual bloomers. This left only 15 per cent of the lot which were considered worthy of a second year's trial, and if they had been selected with the same degree of care as at the present time, there would only have been about 5 per cent.

The number of single-flowered varieties has decreased from year to year with a corresponding increase in good doubles and those having split calyces. The past season showed only about 20 per cent of single-flowered forms. The croppers and annual bloomers have also diminished at the same rate.

At the same time a great improvement has been noted in habit, length and strength of stem, size of flower, greater range and purity in color, better form, and greater freedom of bloom.

To better understand the results obtained, something should be known of the methods employed in breeding. With us the months of December, January, and February are considered the best to carry on the work. The carnation, as it is now grown under glass, is then at its best. It will be found that work is a little more difficult, at this season of the year, owing to the fact that there is less pollen produced in these three months than at any other time. However, as this is the time of best development, it should also be the best time for selection and crossing.

There is also another factor which makes this time desirable. The absence of insects makes the protection of the flowers unnecessary. In a commercial establishment where from 700 to 900 flowers are pollinated during the season, this means a great saving of time.

The entire time required from the growing of the seed to the time of benching of the selected plants, is less than a year. The seedling

plants are allowed to bloom in the field and the first selection is made from there. This best corresponds with our present mode of culture.

The commercial grower hardly exercises the same degree of care for the prevention of contamination by foreign pollen, as the scientist. By not using sterilized implements, it is impossible to exclude all chances of error. Yet, where records are kept, the work should be done with the greatest care possible. These records, although they may not be entirely accurate, by their great number are still accurate enough for the drawing of conclusions which may be used for the foundation of scientific research. The commercial growers work must pay and his results are best shown in dollars and cents.

The first step in the mechanical operation of pollination is the preparation of the flowers. These are selected before the pollen is ripe and the anthers are removed. At the same time some of the inner petals are also trimmed out to allow room for the development of the pistils. The remaining petals will always tell, if fertilization has been effected, by closing up around the pistils in from one to four days after pollination.

The pistils are mature within a few days after emasculation and are receptive when the upper or inner surface has a hairy appearance. The pollen is best when fresh and is transferred to the pistil by means of a camel's-hair brush. If left too long on sunny days it becomes dry and is difficult to handle. Old pollen should not be used, as pollen is short-lived and soon loses its vitality.

As a result of the high state of breeding, certain lines of work are often terminated by the production of varieties which are entirely sterile, producing neither pollen nor seed. Some varieties may develop seed freely but produce no pollen, while others produce an abundance of pollen but develop no seed. In some of the cases where no seed is produced the pods, to all appearance, develop normally, but when broken open contain a number of smaller pods, each with its pistils, in the place of seed.

These points must all be taken into consideration by the breeder, who often finds that a valuable strain which he is trying to develop may receive a serious check.

The selection of the best and the use of none but the best is the first rule to be observed in the work of breeding carnations.

The use of all annual bloomers, croppers, and varieties showing any hereditary tendencies toward disease must be avoided. The use of any of these is, in fact, a step backward.

In some cases where the variety has some desirable feature which is worth transmitting these may be used, but it is with the risk of introducing again the undesirable characters which one desires to eliminate.

The requirements of a good carnation, such as the breeder is striving for, are many. The true ever-bloomer, which is the best of our present type, has in contrast to its predecessors, a long-jointed and open instead of a short-jointed and densely grassy growth. In the

former, not so many shoots are formed at one time, but each as it is formed elongates and develops a bud. In the case of the latter many shoots are formed at the same time with the result that there is a period of many flowers followed by one of few or no flowers.

A variety soon shows its characteristics whether it is a seedling or a plant grown from a cutting. If the young seedling is an everbloomer it commences to bloom when only two or three months old and a cutting from it blooms as soon as it is fairly established. The flower stem and side branches should appear at the same time. In other words the plant should have branches in all stages of development at the same time. This will give a well formed plant which blooms continuously and has no superfluous foliage. In general the leaves are broader and shorter and the stems longer and stronger than those of its predecessors. This should be the general appearance and there is much room for improvement by selection and breeding in the varieties of to-day.

Among the free bloomers there are strong growers and weaklings. Some have a bluish green foliage while that of others is a soft light green. The latter also have a more succulent stem. Those with the bluish-green foliage are much to be preferred, as they generally have the stronger constitution. Both may have equally good flowers.

In breeding, then, only those varieties which are approaching the ideal habit should be used. Following this method each year, brings us less and less of the old time croppers and more of the everbloomers.

One must work, then, for a well-balanced, strong-growing plant, continually producing new shoots, so that a bench of them will always have approximately the same number of buds and flowers.

In a good flower we look first to purity of color. The bloom must be moderately filled, and not over-filled with petals, must have size, symmetrical form, fragrance, and a non-splitting calyx.

In selecting the parents for a crossing, we first consider color. We must look to the development of purity and brilliancy by the elimination of undesirable undertones, shadings and stripes, and also to the creation of new and desirable shades.

With us the following rules have been employed to secure these results. Pure white is secured by working white on white; yellow by working yellow with yellow or white. Yellow with scarlet will intensify the scarlet or may produce deeper yellow or orange. Scarlet with crimson intensifies crimson and gives the scarlet maroons. All shades of pink may be used together; but for the development of clear pink, all those with scarlet or mauve undertones are not to be used. All pinkish lavenders, mauves, and purples are kept in a class by themselves and should not be used with other colors, as they dull them.

Nearly all the variegated forms have either yellow or white for their ground color. When used with a self, the self should correspond either to the ground color or stripe. When two variegateds are used, the markings should belong to the same color class.

Next to be considered is the calyx. There are numerous varieties which habitually split the calyx and are worthless. There are also some which under certain circumstances split what appears to be the strongest kind of a calyx, while on the other hand, some large flowers are held intact by an apparently weak one. It is not so much the calyx that counts as the rapid pushing of the petals out of it.

The growth of the flower should be completed outside when the flower expands.

Form must also be considered. Any recurving of the outer petals is bad, as it makes the flower look small and ragged. Incurving of the petals is also to be avoided, as it gives the flower the appearance of "sleepiness." The outer petals should expand horizontally well above the calyx, the inner ones may be arranged more or less symmetrically, but must not leave an open center.

Discard, then, all forms with incurving or reflex petals.

The shipping qualities of the flowers should also be considered, as the carnation of to-day must stand much handling. A flower with a fine symmetrical form, broad petals, and smooth edge, will seldom ship well. The petals break or slip one in under the other, and the flower becomes deformed. On the other hand, one with narrower petals irregularly arranged and with serrated edges is the shipper. To hold the two side by side, the former is an esthetic beauty, but the latter is better in massing and can stand handling without being easily spoiled.

Whatever the result striven for, success seldom follows in the first crossing. It may come in the second or third year if the same line of work is followed. The union of two long-stemmed varieties is likely to give short-stemmed forms, but the progeny of the second or third year may have the long stems.

It took 16 years to develop an equally good growing habit in all colors, with good stem and freedom of bloom. During this time many varieties with fine flowers were discarded, as they would have been failures commercially on account of being shy bloomers.

To secure our ideal carnation, then, we must work for (1) purity and brilliancy in color; (2) strength in calyx to prevent bursting; (3) sufficient length of stem and strength to carry the flower; (4) a well-rounded form with an evenly divided and fairly smooth petalage; (5) a strong habit resistant to disease and capable of producing a continuous crop of flowers.

In conclusion one might say that carnation breeding has been, and is yet to a certain extent, very unstable. With such a mass of hereditary properties and traits, results may be secured which would surprise even a scientific breeder. The intricacy of this work and the manifold results obtained, lead one into a maze of conclusions only to get lost. Yet these conclusions help to lead us on to better results. As the work advances our ideals are raised thus adding new stimulation to spur us on.

TUESDAY EVENING, JANUARY 15—GENERAL SESSION.

The Association met with the Ohio State Farmers' Institute and other agricultural organizations in the board of trade auditorium with Dr. W. O. Thompson, President of the Ohio State University, in the chair. A musical selection was given by the Angelus Ladies' Quartette.

PRESIDENT THOMPSON: It is a very great personal pleasure this evening to welcome those who appear on this program; and an especial pleasure to welcome one who is to first appear, and address us on the subject of "Education and Breeding."

Professor Hays was once in Iowa as a student there, and has done some good things in Iowa; but those of us who are interested in agricultural education came to know him first and foremost in the University of Minnesota in his agricultural work there, where he made for himself a place in the affections of the farmers of the Northwest, and established a reputation in the judgment of the scholars of agriculture throughout the country, and achieved a place in agricultural education that is peculiarly his own. He has worked out a place for himself, and has filled it to the satisfaction and pleasure of his friends. There is no doubt about his successful career in Minnesota; everybody there knows what W. M. Hays has done. They do not prefix any title to his name there. It is not necessary in Minnesota, for there is only one W. M. Hays up there.

For some undiscoverable reason he slipped off to Washington—I suppose through the keen insight of Secretary Wilson. He is only in Washington temporarily. We have loaned him to the United States. Later on he will be back and doing his life work in agriculture. He is doing in the Department of Agriculture a work which will endear him to the people who are interested in this great subject. There is not any man in agricultural circles in this country whose introduction here would give me greater pleasure than that of Willet M. Hays, who will speak to us to-night upon "Education and Breeding," and give us some illustrations.

EDUCATION AND BREEDING.

By Hon. W. M. Hays, *Assistant Secretary of Agriculture and Secretary of American Breeders' Association, Washington, D. C.*

Ladies and Gentlemen: I would not be gracious if I did not recognize the kind words President Thompson has spoken. This Association would not be gracious if it did not recognize the kindness it is receiving in this city at this University, at the hands of the Ohio State Board of Agriculture and of these other organizations.

We would not be true to Ohio if we did not recognize this great State—this great President-making State. But, I came here to-night to bluntly ask Ohio to "get busy." Keep on making Presidents if you will, but let us make a great race of industrial people in agriculture, in the city industries, and in home making. (Applause.) Let us, somehow or other, get about 20 cents per capita out of the National and State Treasuries, and let us spread that 20 cents per capita over industrial education.

President Thompson, Prof. Plumb, Prof. Osborne, and all these other good agricultural people of the University have been turning out a lot of students, and our friend Chamberlain here knows how to make a host of them through his paper. Let us get busy with some plan to raise that 20 cents per capita. Uncle Sam should take the lead. Let the General Government put up one-half, and the State put up the other. Divide this good old State of Ohio into districts and let us start an agricultural high school in each district. Of the general appropriation set apart for this purpose let each high school be allotted an equal proportion. In such schools should be taught not only agricultural subjects but home economics. Let us get busy with this problem of agricultural education; let us take hold of the pedagogics of agriculture and make agricultural education available to all the people of this country. We have learned how to introduce the mechanic arts into our city high schools, and we should introduce more generally home economics. In this way you can make more presidents in Ohio every year; you can raise a better race of farmers, industrial people, and home makers.

The money is in this country to do this with. This country has been increasing year by year its earning capacity and its production per worker until now we have the wealth with which we can do this work both North and South. You say that Ohio is conservative. So was Georgia; but seven months ago the State legislature was in session, and it passed a bill for the support of eleven agricultural high schools; and it turned over to these schools $66,000, the prospective increase in receipts from the tax on fertilizers, oils, etc. The legislature required each of the eleven congressional districts that were to get these agricultural high schools to give at least $20,000 to put up buildings. Governor Terrell suddenly got busy, and some men of the Department

of Agriculture went down and looked over the farms that these different districts might wish to select. Another Department man went down to help advise them as to the course of study along lines followed in the agricultural high schools of Minnesota and Nebraska, and some of the other States. Governor Terrell found an architect and had a plan made of a suitable building for these agricultural high schools. When Governor Terrell got through with them, these districts had raised nearly $825,000 to furnish the buildings and equipment of these high schools. What Georgia can do to-day, with her population and wealth, Ohio can do three times and over. (Applause.)

Governor Terrell is an enterprising man. He saw that $66,000, or $6000 per school, would not do the business. The people had to pay more money for more buildings and equipment than he had anticipated. What did he do? He did not know how to go back to his legislature and ask for money. It would be two years until another legislature met, and another man would then be in the Governor's chair, and he wanted to get right along and do business. So he came to Washington, found his congressmen, and one of them introduced a bill providing that $10,000 should be appropriated out of the Federal Treasury for each school that would be organized of that class. Another Congressman from that State, at his suggestion, introduced a bill appropriating $2500 for each of these schools, providing the State would put up an equal amount.

There is still another proposition under consideration by some of these same men, namely, that the Federal Government appropriate out of its revenues a sum equal to 10 cents per capita, the same to be turned over to a system of agricultural schools. This would give to the State of Ohio $200,000 for agricultural schools, and if the State would contribute an equal amount we could put industrial training and home economics into those schools.

But I am not going to dwell on this matter. I am not saying whether I favor this tax a great deal, or not. I am going to talk to-night about education and breeding. Suppose this grand old State of Ohio had such a system of agricultural high schools along with its agricultural college and experiment station. After twenty years, Mr. President, under your wise direction, those agricultural high schools could graduate a sufficient number of men trained in agriculture, and trained to give instruction in agriculture, and a sufficient number of young women trained to give instruction in home economics, to do elsewhere throughout the State what you have already so magnificently done in the northeastern and some other parts of this State—consolidate your rural schools in districts about 5 miles square. These high schools would work in cooperation with and as preparatory schools for your agricultural colleges; and when the system is fully completed and under way you can reach 200,000 boys and girls and give them thorough agricultural training and training in home making.

This country has spent in the last twenty years something like $25,-

000,000 in research in agriculture, and other countries have also spent about the same amount; and, with the prospective increased appropriations along these lines, there will be probably $200,000,000, and maybe more, spent in research in agriculture in the next twenty-five years. Are you preparing the machinery for the dissemination among the people of the knowledge which this research will yield?

But I was talking about education and breeding. Now if we have such a system as this we want more sub-stations like that at Wooster; we want a branch station attached to say each ten of these branch schools. If you had that, you would have the study of plant and animal breeding provided for at least so far as land and general equipment are concerned. Then you can establish also at each one of these stations a plan of breeding work, and there might be at each branch station a man who would take up at least one department of breeding. There might be at each one of the branch stations a man who would take up this work under some kind of cooperative scheme such as is being suggested. Then at the central station there could be kept a record of the results of crossing in animal and plant breeding, and at your agricultural college also.

Now, I am not going to talk very long. We will have some moving pictures presently. We want to show you a lot of these, in order to drive home in a practical and illustrative way the fact that we can establish these centers of plant and animal breeding just about as well as we can organize factories for ceramics, or for making sewing machines or self-binders or locomotives.

In Minnesota such a plant-breeding establishment is already started. It has been under organization for about fifteen to eighteen years. It has come to that point where it can be enlarged and increased by increasing the units, just as a sewing-machine factory can be enlarged by increasing the equipment for making each part of the machine. Of course, as the years go on there are many improvements that come in, just as in the manufacture of sewing machines there are new inventions that require more or less change; but the systematic project goes right forward in a sort of mechanical way.

[At this point there were exhibited some moving pictures illustrating the technical operations of breeding wheat and also class and demonstration work in some of our most progressive agricultural high schools and colleges.]

REJUVENATION BY HYBRIDIZATION.

By Q. I. SIMPSON, *Bear Creek Farm, Palmer, Ill.*

We have made some research for the casus stimuli of sexual union, with the anticipation that we might find technical reason for the apparent need of bisexual generation in the higher animals.

An unbiased study of living organisms points out the great economy of Nature, from the single-celled monera to an animal so highly complex as man. And, assuming this fact, may we not seek the wherefore of Nature's requirements of male and female, and the many unique preventives of self fertilization in hermaphroditic plants and animals.

No man who has produced hybrid animals by the union of two long established pure races, has failed to note the extreme vigor of these hybrids.

During twenty-five years the speaker has, at Bear Creek farm, variously managed the studs and flocks, including two breeds of horses, two of cattle, two of sheep, and four of swine; and the phenomena from in-breeding, outcrossing, and hybridizing have been the same with all these breeds and species.

In the past ten years, experiments have been carried on with swine; and in this time we have produced hybrids between five domestic pure breeds and the wild breed from the Scharzwald.

Between breeds of wide genesis, like the Tamworth (a pure *Sus scrofa* and the Poland-China (by selection now a nearly pure *Sus indicus*) we get progeny that are practically a hybridization of distinct species. And our observations and those of many of our patrons have shown a maximum increase of weight, over the pure breeds, of nearly 100 pounds at twelve months of age.

We have crossed the plethoric dull Duroc with the vitalistic Tamworth—both identically red—and visitors to the farm have detected the hybrids by their vigorous potential individuality.

You that have Vol. II of the American Breeders' Association have read the writer's citation of degenerated tribes, strains, and breeds; and it would impose upon your time to requote instances here; but for the benefit of others I will illustrate, with the Bates, Young Marys, and Rose of Sharons that were once famous in Shorthorns; the Stoke Pogis in Jerseys; and the once great Ohio breed of swine, that, while carrying its complexity of origin, drove out from the American corn belt every British breed. But like the defenders of a siege—through famine of unlike germ and somatic cell polarity—it is fast succumbing to the races of more recent origin.

In a talk to this body last winter, the writer named the four discovered factors of dynamic polarity, namely: Hybridizing, Out-crossing, change of nutrition, and change of climate. Since then we have found no new factors, and no new reason for changing the order of

these as named. The factor "Change of Climate," differs little whether the parents are removed or the individual is taken to a new climate. One-year-old and two-year-old Texas steers taken to Montana exceed, by nearly 300 pounds weight the mature steers in Texas. And yearling and two-year-old trotters, taken from Illinois to Montana, appeared to the writer to have grown much larger than brothers that remained at Bear Creek.

Belonging to this category are children of European parents brought here while young, or born here; of which there seems but little difference in their extraordinary increase of mental and physical energy.

Let us offer here a technical, microscopic explanation of polarity, vigor, or energy (termed by Spillman, biologic potential) in offspring that have benefited by one or more of the four dynamics named.

All life, whether plant or animal, has for the commencement of the individual, a single cell. And in the higher plants and animals this single cell, or life speck, is contained in the egg of the female. All higher organisms are bisexual, *i. e.*, the germ cell in the egg of the female requires the union of the sperm cell (spermatozoon) of the male before there can be cell division to build up the organic structure.

The building up of a corn plant or the building up of the living carcass of the hog, from single cells, is as simple, mechanically, as the building of a brick house. And if we will imagine the single brick to have power to grow, in length to the size of two, and to divide in the middle thus forming two separate bricks, and so on successively until the edifice is completed, we have an illustration of how the hog and the corn plant are built. However, the brick has not the power of growth and division, nor has the unaided cell. So here comes the kernel of the discourse.

Microbiologists have discovered what can make the cell divide to form two; thence successively four, eight, sixteen until the countless millions of cells have been laid—layer upon layer—to the completion of the mature living organism.

The first germ, or life speck in the egg lies as dormant as the brick bat, and soon dies without division; but should a male (sperm) cell enter the ovum there is a magnetic attraction between the two; they partly unite, and the union of these two unlike substances produces an electrolytic battery: and when this battery has started the electric engine is in motion. At this instant the cell is an animate individual and depends only on the yolk for nourishment, as the pig depends upon his mother's milk for nutriment to complete his growth.

There can be strong and weak batteries; and here is another kernel: When the germ and sperm have united to form the first living cell, before it can grow and divide to form two, there must appear at the extreme ends of the oval cell two polar asters, termed centrosomes; and it is from these and the cause of their origin, the writers derive the term Polarity of the cell. This polarity or polar-force is augmented by hybridization or other factors of potential cell division.

Edison, Bell, and others have experimented with the mechanical bat-

tery. Hertwig, Morgan, Loeb, and others have experimented with the living battery of the animate cell; and these last have shown the cause of the polaristic controsomes that must exist before there can be a division of the cell and consequent growth. Let us remember that the second and succeeding cells also require the polar centrosomes.

Oscar Hertwig (The Cell, 1902) produced four polar stars, (the normal cell has two) in a single mother cell, with a .05 solution of quinine sulphate, in the fertilized egg of a sea urchin. A. D. Mead, in 1898, found that if a little potassum chloride was added to sea water, the unfertilized eggs of a sea annelid threw out polar bodies. T. H. Morgan produced similar results with common salt. And Jacques Loeb produced living swimming larvæ from the unfertilized eggs of a sea urchin, by a carefully compounded solution of common salt, added to a fixed amount of normal sea water.

Other Microbiologists have obtained similar results; so we deduct from all this that the formation of the polar forms (the centrosomes) are caused by electrolytic action. For in every case where the eggs have been artificially stimulated to form polar subjects, it has been done by an electrolytic chemical, *i. e.*, a chemical compound that is easily broken up into its several parts, and which in so doing generates heat or power.

But you may say, before we conclude: "What effect can the extraordinary polarity, by hybridization of the mother cell, have on the last somatic, or body cells of the mature animal?" We could not answer this were it not for the positive proof (of the non-amalgamation and continued separation of sperm and germ) by the greatest biological discovery since those of Von Baer, 1827. We refer to the laws of hybrids, established by the experiments of Gregor Mendel, nearly a half century back; and hid away until discovered by three botanists in 1900. Two years later, these were fully demonstrated and applied to animals by Bateson of England and Castle of Harvard. With my father and brothers, I had often noted a "throwing back" to lost colors and characters, in second-cross hybrids of horses, cattle, and swine. And in 1901, Spillman had noted a re-separation of unit characters in his work with wheat hybrids.

Here is a solid hoof [exhibiting the hoof] that was taken from a sow that was sired by a male, who, as well as herself, had ordinary split hoofs. The fact is that the grandsire of the animal from which this hoof was taken was a mule-footed hog.

Let us here recall two of Mendel's laws to prove the above statement. First, the law of dominant and recessive characters in the hybrid progeny of two pure breeds, wherein one character (the recessive) seems to be obliterated; but it is "not dead but sleeping," for, in the next cross (second law—the mating of two of these hybrids), we get, for instance, pure white dominant Chesters and pure black recessive Berkshires. At Bear Creek we have proven these laws, with various matings between five of the domestic breeds of swine and the wild species of the Black Forest.

In our matings of first-cross hybrids, sister and brother from same litter, (from which circumstances we have termed their offspring sorofrat progeny) the produce has given us a re-separation of pure color characters, and in some cases a re-separation of pure form characters.

This separation of Mendelian unit characters is the key that unlocks to the biologist the hidden archives of cytologic knowledge. We discover, there, a volume that was compiled when Haeckel's monad was born in the Silurian sea. We learn from it that in the conjugation of male and female, to produce the mother cell, there was not union; but only a coming together of two unlikes to form a living electrolytic battery! The he and she—the copper and zinc—remaining pure and nearly uncontaminated by one another, in the mother cell, in the second cell, and in the million succeeding cells—even to old age in the individual. And we now believe that the last cell, budded onto the nose of the mature hog, or the ultimate repair cell that closes up a wound on the finger tip of an old man, contains the polarity, the "biologic potential" given to it by the long nearly uncontaminated genesis from cell to cell of father and mother, sperm and germ.

I wish to remark here that I have found no difference in results whether I use the male or the female in making a cross. I have produced quite a lot of hybrids. I have hybridized with a strong diversity of color, like white and red, or white and black. I have had Berkshire males and Chester White dams; and then turned right around and used them the other way, and I didn't see a bit of difference in the world.

We have produced hybrids from a white hybrid boar, three years of age, and a white hybrid sow, four years of age, that were as rich and pure red in every hair, as the purest Tamworth from England. Could we get this result from such mating, if there had been amalgamation of sperm and germ?

This continued cell polarity, this hybrid energy, gave to Ohio hogs Tom Corwin 2d.; to Shorthorns, Young Abbottsburn; to astronomers, the Jew-Christian hybrid, Herschel: and the union of New York Dutch and Virginia English has given to America the most strenuous individual that the world has ever known!

There is now at Bear Creek farm, a four months litter of triple breed hybrids—Tamworth—Yorkshire—wild. Two of these are in color and form, nearly pure Tamworth; two are in color wild, but in form York; one is nearly a pure York in color, but in form and hair texture Tamworth; while the last one fully shows his triplex origin, and thus happily (if even accidentally) proves my theory of "polarity by hybridization." Allow me to describe him: In size, he is the largest of the litter, is a light strawberry roan with seven longitudinal stripes of redder hue. Across his shoulders, laterally, is a white band. In nose and ear, he is a Tamworth; in body contour, he is a sunfish wild. In texture and length of hair and length of neck and rump bristles, he is an exaggerated wild, the bristles of the neck being so long that while very coarse, they fall to the left side like the

mane of an unsheared mule. However, it is his neuro-psychologic development that is of greatest interest to this theme. With a pocketful of loose grain we go to the wooded field, where thirty of like age, both pure and hybrid, roam. This fellow first retreats from our collies to safe cover; then, with massive bristles raised, he walks into the bunch that has gathered round, and with the air of a conqueror proceeds to monopolize, by pushing and knocking, the place of most thickly scattered corn. This bundle of potential cells contains the requirements of a soldier and a politician; and if he were a boy, he would lead armies and govern his kind.

Applicable to this is a quotation from a friend that is famous as a cock fighter: "If I were ruler of China, I would import ten thousand Hibernians, give them liberties, and in four decades proceed to conquer the world."

Without burdening you further with instances, I will hasten to the summary of what can be applied to our regular breeding operations in plant and animal. When all the individuals of the litter become uniform; when the crop of calves become, in form and color, alike; when a breed of animals, with the rapid genesis of swine, has existed under the same environment for a half century; when a nation, through religious barrier, race prejudice or otherwise, has had no new infusion for a thousand years; there is then need for rejuvenation in the cells of the individuals to be produced from these.

We have given you the four dynamics. Their strength of dose stands perhaps in the order named; and by noting the symptoms, the proper remedy is indicated.

From observation of the race horse, we can deduce by analogy, a plan for the rejuvenation of our degenerating American breeds of swine—by exporting and after a few generations importing, the progeny for out-crossing. Or, for more rapid results, we can create more liberal registration rules, allowing breeders to hybridize and yet leave their animals eligible to registry.

An analysis of Shorthorn history, from the Collings' first purchase to the present, is sufficient to establish empirical rules for the breeding of all animals. Either dynamic disturbs the cell—hence disturbs heredity. The breeder of Plymouth Rocks is cautious with the dose. The breeder for pork, mutton, wool, speed, gameness, intellect or vital force can inject a ranker infusion and start the hereditary pendulum of variation to more violent motion. The antidotes for the overdose are inbreeding, static nutriment and fixity of location. The pedigree is our clinical record. With this before us, we read the history of conditions that brought about the various grades of degeneracy.

Biologists, with powerful microscopes, have shown that, while the egg in bird and mammal is immeasurably larger than the spermatozoon, the nucleus (the germinal life speck) in the egg is a tiny thing, no larger than the corresponding life speck of the male; and has only equal potential and equal hereditary power.

The egg, as a whole, bears the same relation to the embryotic germ,

as a corn field does to a pig that feeds and roams therein. This exact equality in male and female conjugation, is taught by the microscope, and from our many experiments of first-cross hybrids; while other tests showing unequal potential, in three-quarter hybrids brings the simile of a horse pulling at the whiffletree with a horse of three times his power, and breeds various scrubs with only an occasional good one.

Perhaps every man in this audience, who breeds swine, has formulated the empirical law that the first cross is good, and the second cross is bad. But have all of you thought to apply this essential law to the breeding of pure pedigreed races? The mating of a pure Scotch with a Bates Shorthorn is as true a hybridization and obeys the laws of hybridization as surely as the cross of Shorthorn with Angus.

When the American Breeders' Association has brought together profound biologists and great breeders; when the artisan and the architect are brought into union, is it a dream to say that we may yet build vital forms as the sculptor molds the plastic clay?

The Angelus Ladies' Quartette then favored the convention with two vocal selections.

PRESIDENT THOMPSON: We have had a very pleasant experience here in our excursions into the world of animal life. We shall now for a little while take a journey among the flowers under the guidance of Prof. J. B. Norton, who comes from the National Capitol, and who will now address you.

HEREDITY IN CARNATION SEEDLINGS.

By J. B. NORTON, *U. S. Department of Agriculture, Washington, D. C.*

In 1904, at the request of Dr. H. J. Webber, the writer began taking notes on an extensive series of seedlings of the American carnation grown by Mr. E. M. Byrnes of Department of Agriculture. These were the result of crosses between several standard clonal varieties, but in all cases showed no uniformity of type in regard to doubling, singles appearing in every series. The percentage of singles appeared to be rather constant for the different lots, the general average for the whole lot being about 23 per cent of singles to 77 per cent of doubles. The doubles varied in the amount of doubling but could be roughly divided into two groups, standards and "bursters" or full doubles, the latter making up about one-fourth of all the seedlings. These percentages agreed so closely with the second generation results of a Mendelian hybrid that the writer at the 1904 meeting of the Society for the Promotion of Horticultural Science, at Philadelphia, ventured the opinion that the standard greenhouse carnation of this country was the unfixed hybrid of a cross between a single and a full double and

that 100 per cent of standard doubles could be raised from a cross between a single and a full double carnation.

Several crosses of this kind were made in the winter of 1905-6 and so far the 250 seedlings that have bloomed, with one exception, are standard doubles. In all cases the crosses were made on single seedlings using pollen from the full doubles. No protection from outside pollen was used and the presence of flies and bees in the house would easily account for the one single seedling.

This method of crossing is not recommended as superior to the old method, but is advanced as a suggestion to aid carnation breeders in their work. Single and very double seedlings heretofore have been thrown away no matter how desirable their other characters might be. By pollinating a good single with the pollen of a "burster" that has some new desirable quality, a complete series of standard double seedlings can be obtained, thus giving twice the ordinary possibilities of success in fixing the new character since very little over 50 per cent of standard double forms are obtained when two standards are crossed. The seedlings produced by this method that have bloomed thus far give quite as much promise as any produced in the Department houses from standard varieties or from standard double seedlings.

While this work does not prove that the carnation is following Mendel's law in regard to doubling, it offers evidence that any one familiar with Mendelian hybrids would accept as satisfactory proof. Another practical application of this method would be in the production of double-flowered garden pinks. At present many of the varieties on the market produce about 20 per cent or more of singles. If these single plants were pollinated with the pollen of full doubles, a high grade of commercial seed would be produced that could be guaranteed to produce 100 per cent of double flowers. It is possible that this method of seed production can be applied to other double flowers outside of the genus Dianthus.

No discussion was had, owing to the lateness of the hour. President Thompson announced the various program features of the morrow, and gave visiting members full directions as to how to reach the meeting place.

PROFESSOR HAYS: I would like to ask if there are any resolutions to be handed in at this time, or any other business that the members and friends would like to present to the Council or to the Association?

While we have a moment I want to say something about the program of to-morrow evening. Some of you heard me speak this morning of the various committees. I mentioned the committe on breeding wild animals. Some of our wild animals, for example, the buffalo, some of the antelopes and elks, mountain sheep, etc., are becoming extinct. There is a movement at this time going on to preserve these, in which movement the Government is taking part.

There is also a movement rising with a good deal of power to use these hardy animals for cold climates like the high mountains in our northern regions. The idea is to use these hardy wild animals there to produce meat in a sort of wild way. The leader in this kind of work is Colonel C. J. Jones, of Arizona—"Buffalo Jones." He is going to give us on this platform to-morrow night as good a show as the ordinary theater. He is going to talk some hard common sense and practical Americanism about these great interests that are both of scientific and practical value, and will especially appeal to the people who like wild game. He will have a moving picture machine, and is going to show you male buffaloes fighting, whole herds of buffaloes, great droves of antelope going over the hills, and himself fighting with a mountain lion in a tree. He is probably America's greatest intermountain hunter and plainsman. He is coming to this Association at a great sacrifice, as he has been making from $100 to $500 a night with this lecture, which he is going to give to this Association and this city free.

I hope the newspapers will fill this building; and I rather suggest, Mr. President, that this Association provide tickets for our members and guests, with reserved seats, so that the people from outside will not crowd out your visitors.

Then the convention adjourned.

WEDNESDAY FORENOON, JANUARY 16—SESSION OF THE ANIMAL SECTION.

The Section of Animal Breeding met in the University Chapel with Hon. A. P. Grout presiding.

Chairman GROUT. The first topic this morning is an address on "Teaching Animal Selection," certainly a very interesting topic to us all, by Prof. C. S. Plumb.

TEACHING ANIMAL SELECTION.

By Prof. C. S. PLUMB, *Columbus, O.*

MR. CHAIRMAN, LADIES AND GENTLEMEN: The subject of "animal selection," more commonly termed in this country "live stock judging," is one of the more recent features of agricultural education. So far as I am aware Professor Craig of the University of Wisconsin was the pioneer in systematic work along this line. It should also

be mentioned that several very bright Canadians educated at the Ontario Agricultural College have been leaders.

In the early work in agricultural education in the United States there was much difficulty encountered in securing students from the fact that the educational work was more or less unpopular. I believe that in the earliest work done in teaching animal selection the aim was to make the agricultural work more popular in the colleges. We find in general that teaching this subject in our agricultural colleges is popular by reason of the love of domestic animals that the average young man has; and so, when Professor Craig projected this work, he hit a rather happy solution of one problem, i. e., how to get young men in our agricultural colleges interested in agricultural education.

THE TEACHER.

There are some features which are important in the teaching of this subject. One of the most important is the teacher. Now there are teachers and teachers. A man may be a first-class judge of an animal, but he may not be able to tell you why he forms his judgment. He may not be qualified from the standpoint of imparting his knowledge to others, and that is a qualification which is highly essential to the teacher. The real teacher has the ability to impart his knowledge of a subject to the student in a clear and systematic way. A teacher ought to have received special training along teaching lines. In the early days we had a class of teachers who had received no such special training. I sat for four years under some teachers of agriculture myself that would not be mentioned in the same class with many of the teachers we have to-day. Why? Simply because they had no qualifying training; they had gotten their education by rather crude methods, and they were really deficient in ability to properly present the subject to the class. To-day we demand trained teachers, to judge animals keenly and wisely, and who know how to present the subject to students and make efficient trained stockmen out of them.

THE EQUIPMENT.

Another feature that is necessary is a well equipped laboratory. In regard to this feature, I often think that we are in an absurd situation. The live-stock interests of the United States run up to such tremendous total value that we really cannot get any fair conception of it. Here in Ohio our live-stock values run up into the neighborhood of $1,000,000; and yet our equipment for teaching the subject is a mere trifle in value. We have agricultural colleges in this country to-day that have not equipment worth $2,500 for teaching this great and important subject. A sufficient equipment is an essential feature if we are to do satisfactory work in teaching the subject of animal selection.

This equipment may be related to the institution from two points of view. It is essential that we have in the equipment of the agricultural college itself a collection of animals which will represent to

a reasonable degree the breeds of the State and the types. We have types of animals which may be considered irrespective of breed, and we have types within the breeds. An agricultural college that is going to teach this subject in a clear and useful way must have a reasonable collection of the types to emphasize the subject to the classes.

Then, the neighborhood surrounding an agricultural college may furnish material to supplement the equipment of the college. Take the case of an isolated college off in one corner of a great State, with poor railway facilities and farms widely scattered. In such a case, we are likely to find a minimum of facilities for use in this work. On the other hand, take Columbus, Ohio, as a contrasting illustration. Here we find a great live-stock State, and a great city like Columbus in the center of it, with great railroad systems coming into it; we find an interurban system, and stables conveniently near; some of the finest herds and flocks are just a little way out, so that you can get on an electric car and visit them. Thus are provided valuable accessories to the working equipment where one wishes to teach animal breeding or animal selection.

THE STUDENTS.

Another feature of the matter which is an important factor in this connection is that we may group our students, and divide the subject also into several classes distinct in themselves. Our students may be divided into two general groups; those that come from the farms, and those from the city. Those from the farms may be again divided into two classes; those that are really interested in live-stock, and those that are not interested. Those that come to the college from the town are oftentimes among our most efficient students.

We find that there are certain characteristics which are to be sought for in the student that are highly valuable as qualifications to make them efficient in selecting. The student must have the eye and the judgment that will enable him to discriminate clearly. If he lacks these, while we may receive very material benefit from his work in the class, still he never can hope to become the efficient judge that he would be if he possessed these qualities.

ILLUSTRATIONS OF METHODS.

Now let me pass on to discuss some of the methods that are used here in the University. I may fairly say that our methods do not differ much from those practiced in the other leading institutions of the country where this subject is taught. This subject of animal selection or live-stock judging, is without doubt the most popular phase of animal husbandry taught to-day in the American agricultural college. There is quite a wide range of subjects taught in our agricultural colleges at the present time. Right here in this university, for instance, we have about ten different classes in animal husbandry. We teach the subjects of feeding, breeding, live-stock markets, wools and

other animal fiber, meats and other products, and a variety of others that are distinctly within the sphere of animal husbandry; but of all these subjects none are as popular with the student body as this subject of animal selection.

The first method that was introduced was that of studying types. We can classify all of our domestic animals, if we wish, into types. There is, for instance, a draft type of horse, and there is the light-harness and the heavy-harness horse that was spoken of yesterday. Then we have our different types of hogs.

Professor Craig in his work has brought the use of the score card to the attention of teachers and students. I hold in my hand a sample of the more common form of score card generally used to-day. This score card is based on the assumption that we have an ideal animal in mind.

The student will approach the animal from several points of view. In the first place, he will take a survey of its general appearance, and on his score card he marks up for general appearance so many points with reference to its degree of approach to the ideal animal. The general appearance includes the general form of the animal, his quality and his weight, and a few other features that are at once caught by the eye. Then the animal is gone over in a systematic fashion. First, the head and neck are considered, and the various parts of the head and neck are taken separately, and a certain number of points are given to each. Then a study is made of the shoulders, the body, the hind quarters, and, if it happens to be a dairy cow, to the udder. That was the first systematic method adopted and it gave our stock students a means of studying the animal form. It had an advantage in the study of only one individual at a time. The student by going over the score card with the animal in front of him was led to carefully follow out the details of conformation of the animal and to set down in the blank space the number of points that he thought should be given to the animal before him as compared with the ideal. The chief value of this method was to direct the attention of the students to the details of conformation. The student also was taught to go over the animal systematically.

After this method came that of making use of the score card in the study of breeds. Most of the breeding associations of to-day, particularly those in the United States, have score cards of their own. I have in my hand a score card published by the American Jersey Cattle Club which is the result of the combined judgment of some of the leading Jersey breeders of the country. It is made up on the same principle exactly as the other score card that I have called your attention to; but, as the official score card of a great Breeding Association, it has a very distinct value. It may be used and is used to some extent in special breed study.

Then we have the comparison of animals in groups. After the student has become somewhat familiar with the individual, so that he is able to determine somewhat the points of advantage and disadvantage and to indicate the value of each on the individual score card,

groups are brought before him. One of the most elementary and yet one of the really valuable features in connection with group study is in the comparative study of the various parts. For example, supposing you bring into the class room four horses, and they are lined up before the class, as you find in any ordinary horse-show, and the class is given a lesson in the study of heads—comparison and contrast of the heads; character of the eye as indicating the disposition and temperament; breadth of forehead as showing something of the intellectual capacity of the horse; general character of the nose, mouth, and teeth, as showing something of the value of the horse as a feeder.

In connection with the work in the class it is usual for the instructor to give preliminary discussion when the question of types is taken up, in which the students' attention is directed to the various important features of the work; and then the student is given the work in hand and is required to attempt a comparison of the parts in a group of animals: For instance, a comparative study may be made of the udders of cows, or of the legs of horses or of any other animal in which the character or the position of the legs is important. The position of the legs of a horse has a great deal to do with his movement; and, in the case of dairy cattle, the position and character of the legs has an important bearing on the capacity of the animal to develop an udder and thereby produce milk.

After the particular features are gone over in group studies, the student takes up comparative study of the whole animal. Here we come to the sort of work that is required of the professional judges in our show-rings.

The ability of the student to reason is quite valuable. It is an interesting thing to take a class of twenty-five students and go with them over a collection of animals and note how certain members that you might reasonably suppose could see things with a clear eye have distinct difficulty in seeing a thing from the same point of view as the instructor and a large majority of the class. It is a matter of education, of the training of the eye, of learning the relationship of function to conformation.

It is a customary thing to take students out on trips to breeding farms and also to feeding establishments in order to give them opportunities to compare the animals and to observe the influence of heredity. For instance, a visit may be made to a horse-breeding farm, or to an establishment where they deal in breeding horses. In this way it is possible to present before the class some very beautiful illustrations of the prepotency which obtains with certain animals. I remember once that I went with a class to Lexington, Ky., where we visited a noted stock farm, and the manager of the stud brought out a famous stallion, and, following him, four other animals which represented three generations, and they were as much alike as so many peas.

One of the most important phases of animal study is the matter of type within our recognized breeds of domesticated animals. For

example, we have a Shorthorn breed, and within the breed there are certain distinct types. We have the Shorthorn as developed by Amos Cruickshank, a type that is rather common in Pennsylvania; we also have the Shorthorn that Bates developed, of which we have so many fine illustrations in the United States; and there are other types which appear in our great international show at Chicago.

A criticism ought to be made on a prevailing practice in our agricultural colleges. The work began with the idea of popularizing agricultural education, and in order to hold the student he was given work in stock judging at a rather early stage. Quite a good many of our agricultural colleges give this work to their freshmen students. In this way young men are brought into our institutions and put to work in a field that really requires very good judgment before they have had the fundamental training which should precede such work. The student that has maturity is a better judge than the immature student; consequently, the student that has had some education in animal physiology is better prepared to take up work like this than the green student who has just entered college. I believe that one of these days we will have a course of training which will include preliminary instruction in the structure and physiology of our domestic animals before stock judging is taken up.

The work of instruction in this subject has been constantly growing and the class of instruction is becoming more and more profound. We are now developing lines of work which should make the students in our agricultural colleges more efficient judges, and better able to select animals on the basis of type and values.

DISCUSSION.

Chairman GROUT. Does anyone desire to ask a question? It may be that there are some breeders of cattle or live-stock here that would like to put some questions.

Mr. Q. I. SIMPSON. I would like to ask Professor Plumb if in teaching stock judging now there is any great attention paid to what we call the breeding type.

Professor PLUMB. Yes, sir. I did not refer to it, although it came within the consideration of types. The breeding class to which you refer is based on the various factors which go to make up the producing animal.

Chairman GROUT. You spoke of teaching students to judge of the conformtaion of an animal. Does conformation always indicate the economic value of an animal? For instance, in the growing of beef can you tell which animal will take a given amount of feed and convert it into the most and highest priced beef in the shortest time? That is the thing that the farmers want to get at.

Professor PLUMB. Yes, sir, as a rule. There are always exceptions, of course; but it is safe to say that we can present before our

students those qualities which ordinarily are associated with a good feeder, or a good killer, or a good speed animal, or whatever we care to secure.

Chairman GROUT. Isn't it a fact, Professor, that, for instance at a fat stock show, many of those animals that are awarded premiums are not the most economical to feed, but that they have been fed for a long time and at great expense; whereas other animals possibly would have made a greater gain on the same amount of feed?

Professor PLUMB. Well, I suppose that at our shows we are exhibiting for other purposes than purely to secure a given amount of weight; the average man has at stake the winning of a premium, and the cost of getting it does not weigh with him, in comparison with the advertising value of securing such a premium. If I were in the business of showing I would not care particularly as to the cost, unless it might be absolutely extravagant. I would not care so much about the cost so long as I secured the results. For example, one institution in this country bought a steer at auction for over $600. It was criticized for extravagance, but the expenditure was a fine business investment, because great judgment was exercised in the purchase, based on a knowledge of animal form and what might be expected from such an animal. That single investment brought back to that institution over $1,000 and also a great deal of prestige for success in handling it for a year, as in competition with exhibitors from Canada and the United States it carried away the highest trophy to be obtained. Now if the best judgment had not been exercised by the trained men who selected that animal, they could not have selected him as wisely as they did.

Chairman GROUT. It seems to me, Professor, that when the boys come to an agricultural college to learn to judge animals, it is not for the purpose of picking a winner at a fat stock show or anything of that kind; but, it should be for the purpose of enabling them to go back to their own farms and select those animals that will make the most money for them.

Professor PLUMB. I agree with you thoroughly on that. I do not think the stenographer has me on record as saying that we make a specialty of training our students to judge at shows. In fact, the matter of selecting show winners is one of the most insignificant features of our education; but we do tell our students that the highest type of animal, the one that approaches nearest to the ideal is the one that logically ought to win at a show. Now as to the cost of producing a pound of beef or mutton, that is another question.

Mr. SCHNEIDER. I would like to ask the Professor whether the animals that win in the show ring are as a rule the most profitable or of the best type; whether the animal, especially the hog, that wins in a show ring is the most profitable type of hog for a farmer to feed to make pounds of gain?

Professor PLUMB. You want to know whether I teach my students that or not? We are talking about teaching.

Mr. SCHNEIDER. No, I want to know whether you teach your own students to select that animal in the show ring which is the most profitable animal for a farmer or feeder.

Professor PLUMB. I might answer that question in this way: If I should visit your herd and pick out one of your Poland Chinas, there is not any likelihood that you and I would disagree as to which would be the best one for me to buy if the University wanted to buy a breeding sow. We teach our students that when we are buying beef animals, or when we are breeding beef animals, we should look for those animals that produce the maximum of the qualities that the market pays the highest price for. Now in regard to the value of a breeding animal and the value of a show animal, I want to say that some of the most noted show animals that have been known in this country have been some of the most noted breeders and they are alive to-day, and their progeny are scattered all over this country. They have not only been noted in the show-ring, but have become noted in the stud afterwards. Some of the most noted breeding animals that have lived in Australia in their time have been noted show animals. On the other hand, some of the most noted animals that have ever lived have been anything but show animals. Champion of England, one of the greatest Shorthorns that Amos Cruickshank ever saw, was so ungainly in his eyes that he only used him as a last resource; yet he was the making of his herd. Even Amos Cruickshank would recognize the fact that, because an animal is not meeting all your requirements, it does not follow that we should not expect good results. We must work towards an ideal. That is what the great breeders have done, and we teach or students that.

Dr. BROWN. I would like to ask what proportion of your estimate of an animal do you base upon his ancestry; that is, if his pedigree for three or four generations includes only creditable animals, even though the animal itself may not be up to the standard, how much of the lack of those elements in him do you overlook because of his excellent ancestry?

Professor PLUMB. Well, I did not discuss the question of pedigree but I would not have you think that the matter of pedigree is overlooked. Pedigree is a subject which we teach a great deal of in connection with the subject of heredity or, as we call it, the principles of breeding. In that connection our students get a great deal of work on the value of pedigree. I have been really considering those subjects from the standpoint of the judge rather than from the pedigree point of view; but I illustrated that matter somewhat when I called your attention to the fact that we had brought before the class a sire and his offspring that represented the value of pedigree or prepotency. I might explain that we have a very large and valuable collection of herd and flock stud books from all over the United States and Great

Britain, and our students go through these books in a systematic way in a series of lessons. Each man has a large sheet on which there is opportunity to record and make a study of the pedigree of animals for six generations. In studying this subject of heredity the student is given the name of the animal, which may perhaps be in our own herd, or possibly some famous breeding animal, and he is required to study the pedigree of that animal down through the herd books, and then at the right time after he has become familiar somewhat with the process of working out the pedigree, he is given further instruction concerning the origination, I might say, of the value of the pedigree, the famous animals which may exist all through it and what has been their performance; and so in that connection we have the year-books of the American Trotting Association, giving the speed of the horses so that the student can follow that part out. We have the butter test books of the American Jersey Cattle Associations and of the Holstein-Friesian Association. Then we are somewhat familiar with the records made by animals in the show rings, and in that way a study of pedigree can be made by the student, in which emphasis is placed upon the importance of breeding to blood lines.

Mr. A. J. GLOVER. Do you take into account records, or do you make block tests of those beef animals to know the percentage that their carcasses dressed out? What I want to get at is this: A few years ago the Minnesota Experiment Station shipped to Chicago a steer—a Shorthorn, I think, but it matters not what breed. He got third place. We brought him back to the station and slaughtered him, together with what we call a good feeder, a pretty fair dairy steer. Now the steer that took third place at Chicago didn't dress out as much table meat as the dairy steer. A flank was sent up to the culinary department and was rejected because it was too fat. I think that Prof. Hays will remember that. It was done by Prof. Boss, who is rather a "dry joker," and he knew that it would be sent back to him. Now as I said the steer that took third place at the Chicago Fat Stock Show didn't dress out as much table meat as the dairy steer which we didn't consider worth raising for beef. Are you making tests to check your judgment on those things?

Professor PLUMB. Not yet, and I will tell you why. At this University when it comes to slaughter-house accommodations we are not situated as Minnesota is at present. Your question implies feeding the animals, having the students go over the animals, passing judgment on them, and grade them, and then, after having the animals slaughtered, letting the students have an opportunity to examine the carcasses. We are not so situated as to be able to do that here; but we are carrying on some feeding work. At the last International we had an animal that was fed particularly for the carcass test there. He was not fed for the purposes of the open show-ring; he was held back; he was not fed in the same way. He was fourth in the class of two-year-old cattle slaughtered there. We expected that that steer

would "get into the money,' but we knew he would not if we showed him in the open class.

It is not fair to go on the supposition that, because an animal gains in weight, he will bring in the market just as much money as another animal that may have the same weight. It is not fair to assume that because a dairy steer gains so many pounds a day and attains a certain weight at the end of a certain time as compared with, for instance, a Polled Angus steer, that there is not a difference in the value of those animals in the market. There may be more waste there and not the quality. There are several sides to the question. Our students are taught to recognize what conditions make one steer better than another, and where breed comes in as an influence.

Mr. GLOVER. Don't you think that we are really missing a fundamental thing by not making block tests in our colleges? Understand, I am not blaming anybody, but do you not think that we are missing the main point there? Now, I am a dairyman and have studied the question all my life. In passing through the Wisconsin State Fair a few years ago I saw a man milking a Guernsey cow. The judge about that time appeared on the scene, and this man said to him, "Mr. Goodrich, if I had had any idea that you were going to be Judge, I would not have brought this animal." The old gentleman said, "Is that the best animal you have on your farm?" "No, Mr. Goodrich, that is the poorest animal I have in my herd, but she is a mighty good show cow." He had paid $1,000 for that animal because she had won so many prizes at our fairs, yet she was one of the poorest cows. At the bottom of the whole thing is this, when we are breeding dairy cows we should breed dairy cows that will produce the most milk and butter fat for the food consumed. We should also breed animals that will produce the cheapest and best meat for the food consumed.

Professor PLUMB. "One swallow does not make a summer." That show cow that you refer to might stand right alongside of another cow that would be just like her in appearance and at the same time meet all the requirements of the milk-pail test.

Mr. GLOVER. I fully agree with you there.

Professor PLUMB. I know of a case like the one referred to. You can find exceptions to almost any rule, but we cannot allow those exceptions to have too much weight with us. We have seventy-five head of cattle on this place. We keep records of what the cows are doing which are presented to our students in the course of the work. I did not suppose that I was giving the impression that we are confining our attention entirely to externals. I would not have you think so.

As to the slaughter-house matter, we might have a slaughter-house on this place, for the purpose of manual training, and that is one phase of the work which is presented at the Minnesota High School of Agriculture. We might have such an institution also from the

standpoint of its real technical relationship with the whole subject, and not merely the idea of making butchers, which is not a potent consideration. One of these days we ought to have scattered over the State of Ohio agricultural high schools, in which I think there ought to be agricultural manual training, schools where a lot of the work that is being done in our colleges and universities to-day should be done, and where we will prepare students for more advanced lines of work.

Mr. FERGUSON. How does it come that our judges at fairs are still favoring a type which is not the most economical type for meat animals; why is there such a great difference between the show test and the block test?

Professor PLUMB. May I ask a question in reply to Mr. Ferguson? Why is it that in the United States Supreme Court, the highest tribunal in this land, we may have nine judges, five of whom will decide a great question one way and four another? (Applause.)

Mr. FERGUSON. I would say that those of us who are engaged in the meat end of the business do not want to handle animals that win premiums at the International Show. We would rather take the rank and file, the run of the market during the show week, for profit. I believe in the dollars-and-cents proposition. (Applause.)

Mr. HINE. I just want to reply to that question. The show-ring is not the place where we exhibit sample packages of our herds, although some of the exhibitors may call them so. It is a place where we exhibit the highest development of perfection possible or obtainable in that animal. To get the highest possible development requires an animal of wonderful constitution and wonderful breeding capacity. He no doubt is fed beyond what is profitable to the exhibitor. That is to be expected when an animal is fed with a view to winning a premium at an International Show. It is understood by everybody that he is not fed at a profit from the feeder's standpoint, or that the carcass will be necessarily a profitable carcass to cut up, because of the waste. The animal is expected to illustrate the possibilities of the breed or individual, and the judge has to take the animal as it comes before him, he cannot inquire into how the animal was fed, how long it was fed, or the expense of feeding. That is work that belongs to the experiment stations and the colleges. We must always remember that the show animal is not a sample of the herd, but rather the pick of the herd as to possibilities, and as showing the skill of the feeder in securing the highest possible development obtainable. That is necessary in order to win. An animal that may win on foot at a fat-stock show seldom gets within money on a block contest. That is to be expected, and I think it is proper that it should be so, because it is impossible for the judge to tell how the animal has been fed or how expensive the feed has been. He has to take the statements that are put before him. It is to be expected that every exhibitor will put

forth his utmost efforts in the development of the animal he exhibits to the greatest extent and to the highest possible point; but, as I said before, the animal that wins on foot in a ring contest never gets the money on a block contest.

Professor PLUMB. I wish to announce, Mr. Chairman, that we have here right near the University one of the famous studs of horses of this country. As we have a rather large class of short winter course students here, and also a great many guests, I have asked the owners of that stud to make an exhibition of their horses here so that our guests especially can see some very beautiful types of horses, and so that our students may at the same time have an opportunity to examine them. I think that to-day would be the time to have that exhibition if provision could be made for it, and I would suggest that it be made over here on the grounds in front of this building, or in front of Townsend Hall, at four o'clock in the afternoon. (Applause.)

Chairman GROUT. You can make arrangements, and announcement will be made a little later.

Chairman GROUT. The next order of business will be the report of the Committee on Cooperative Work in Animal Breeding, of which Secretary Hays is chairman.

Secretary HAYS. I am asked to present the report of the Committee on Cooperative Work in Animal Breeding. Before doing that I want to make a statement in regard to the finances of this Association. The Association has something like 1,100 members, of whom 50 are life members. These members are live-stock breeders, plant breeders, horticultural societies, agricultural societies, institutions like libraries, etc.; they pay a fee of $20 which entitles them to a membership for twenty-five years, and during that time without further expense to get the publications of the Association. The annual membership fee is $1. This entitles you to an excellent report annually; so good that the one issued the first year has been used in many agricultural colleges in lieu of a text book, because there is no text book on breeding; the second year's report was so good that the young men about the Department of Agriculture have said to me, "That is the best thing we have got up to date on Breeding." In the way of short practical articles that report is quite exceptional; and it is so because it represents the experience of practical men in the various States; men who are doing things, not merely talking about them, and who represent substantial influences in the science and art of breeding.

The report of this meeting is going to be decidedly the best one of the three.

There is talk about raising the membership fee to $2 next year, and possibly establishing a monthly magazine into which such papers will go, but that is purely speculative as yet.

I do most earnestly hope that every one present who has not already joined will take a membership. It is worth a great deal to you, and it means a great deal to this movement.

I will now present the Report of the Committee on Cooperative Work in Animal Breeding.

REPORT OF THE COMMITTEE ON COOPERATIVE WORK IN ANIMAL BREEDING.

By W. M. Hays, *Chairman, Washington, D. C.*

Your committee on cooperative work in animal breeding begs to report as follows:

The subject assigned to this committee is new. Since only one suggestion for cooperative organization in breeding has been presented in a formal way and that following the lines of a contract entered into between the U. S. Department of Agriculture and the Minnesota Experiment Station, this report of progress will be confined mainly to a statement of that plan, together with arguments for and against it as a plan for wide use.

COOPERATIVE CIRCUIT BREEDING.

Under the name *cooperative circuit breeding*, it is proposed to organize associations and that public institutions shall assist these associations. Under this plan it is suggested:

1. That there be organized, in a group of a dozen or less counties, preferably centered about an experiment station, a cooperative association of 20 or more farmers who care to breed a given class of pure-bred live-stock.

2. That each member agree to purchase and enter into the association circuit at least the minimum number of approved animals; for instance, in case of cattle and swine one male and at least five females; in case of sheep one male and at least ten females; and in case of horses at least three females, males to be owned jointly or individually, or even by the assisting institutions.

3. That the members individually and as an association agree to enter into cooperation with the State experiment station and the United States department of agriculture (or other institutions), and to breed, care for, test and dispose of circuit-bred live-stock under

such rules and regulations as may be provided by council representing the association, the station, and the department.

4. That the Department of Agriculture and the State Experiment Station join on something like equal terms in cooperating with cooperative circuit associations organized to breed live-stock, providing public money for general expenses and providing plans which will be continuously pursued in efforts to produce strains of animals superior for general, wide, economic production and use.

5. That the use of public money be confined to general current expenses as of supervision, testing, valuing, recording, working out uniform methods of feeding and of guiding the breeding in lines of public interest, that large numbers of superior animals may be made available to breeders at reasonable prices.

6. That articles of association, of legal incorporation—of agreement between the Department and the Station, and of agreement among the Department, Station, and Association be executed.

7. That a council of three be created, one representing the Station, one the Department, and one the Association, and that this council make rules and regulations for the government of the circuit project, and that the council employ a circuit superintendent as their executive officer.

8. That the circuit superintendent, acting under the council shall cooperate with the individual breeders in making purchases, in methods of feeding and care, in breeding, in testing and valuing, and in selling their animals so as to apply uniform and efficient methods of the work of producing a breed of greater value to those who wish to secure valuable foundation stock for purebred herds and flocks and to those who produce and use animals and animal products.

9. That the principles of animal breeding may be thus further studied and emphasized under formal records, and that the business practices needed in the creation of improved stocks of pure-bred animals and in the production of useful animals and animal products may be further developed.

For the most part the discussion, both oral and by correspondence, has been very favorable to the plan. One experiment station officer expressed the fear that it would tend to limit or suppress the occasional genius, as Cruikshank; that such men could not effectively work under it. In reply it has been suggested that men not desiring to work in cooperation, or adapted only to working alone, would have quite as free a field as now. It is further suggested that a man with a genius for breeding and also for serving as a superintendent or as a leader within the association will have a much enlarged opportunity to aid in creating new types of peculiar breeding power and value. It is also urged that the results of the work of men of peculiar genius would be better preserved upon their leaving the business, and that much wider use than now would be made of important improvements whether originated within or outside the circuit organization.

Another experiment station official suggested that there are not

available the necessary number of men trained for the work of directing and superintending the proposed projects. While it must be conceded that our colleges of agriculture have not trained men for this specific service, it is certain that they could do so. All new enterprises would fail if the business did not in part create the men. Our agricultural college men could rapidly turn the attention of many young men toward this service.

This cooperative Circuit scheme of animal improvement would accomplish a number of important things:

(1). It leaves the pure-bred animal business in the hands of private individuals, thus retaining in action the full power of private incentive.

(2). It preserves the farmers who become cooperators in the status of individualism in cooperation, rather than service under the government or service in corporations.

(3). It will give to those who train themselves for the work of superintendents splendid opportunities for mose useful public service and for advancement in a wonderfully interesting field of labor.

(4). It will greatly accelerate the development of a science and practice of animal breeding for use by private as well as cooperative breeders.

(5). It will give to numerous localities superior stocks and breeds of animals which will give them besides fame and pride in local affairs large profits from the sale of pure-bred animals as the counties of Durham or Lincoln or the Island of Jersey have profited from pure-bred Shorthorn cattle, Lincoln sheep, or Jersey cattle.

(6). With the development of high-class herds under government supervision will come the better training of the community in appreciation of skill in the breeding and care of animals of superior excellence.

(7). The great prime result will be the production of numerous types of animals, more useful than those now existing to all who produce and those who consume live-stock products.

(8). Instead of lessening private enterprise in creative breeding and in the production of pure-bred breeding animals, a large number of cooperative breeding circuits would greatly accelerate this interest.

(9). Private breeders of pure-bred stock, and farmers needing pure-bred sires would find it a very great advantage to have sources of highly authenticated breeding stock which would bring to their herds blood of proved practical excellenec and reputation backed by authenticated certificates of excellence.

(10). The performance pedigree records built up from the tests employed in singling out the best blood lines of each circuit and making of it the whole of the circuit breed will form a most potent agency to aid in the wider dissemination and use of superior animals.

(11). The show, the sale ring, the advertising journal, and the

private sale would have at every point added dignity and power for advancing the live-stock interests of the country.

(12). Since we have the leading place in the world in agricultural and live-stock production and since our home demand for superior pure-bred stock is the largest, it is but good Americanism that we develop the cooperative circuit plan or some more still comprehensive scheme for world leadership in the creation of new live-stock values and in the international sale of pure-bred live-stock.

WHAT POULTRY BREEDERS CAN LEARN FROM CATTLE BREEDING.

By ROSWELL H. JOHNSON, *Cold Spring Harbor, L. I.*

If we consider the aims of commercial poultry breeding and cattle breeding, a close parallelism is found, since the products are in each case meat from the males and a food product from the living females that is highly variable in quantity. There are of course some differences, such as the age in coming to maturity, the time during which high production is maintained, the different qualities of the product, the amount of product from each individual and its consequent value. These are hardly such differences as one would expect to alter materially the methods of breeding, yet there is a great contrast in conditions. The question arises: Do these conditions differ because of adaption to the different materials or because they represent different stages of development in the practice of breeding? Let us draw a parallel.

CATTLE.	*1. Quality of Stock.*	POULTRY.
A large proportion of cattle growers use males, at least, which are of breeds that have been selected more or less closely with an end in view.		A large proportion of poultry growers use such stock as they or their neighbors have had for years. When selected stock is purchased, it is seldom bought from those who breed for commercial qualities, but from a fancier who has other ends in view.
	2. Selection.	
A large proportion of cattle growers practice some selection in retaining the calves from the dams which are best for their purpose and give thought to the choice of sires.		Selection is practiced by the poultry grower in a large proportion of cases only in a rather indiscriminating way. The hens that have laid the largest number of fertile eggs in April and May and those that are adept in stealing out their nests are more likely to be the dams, and the handsomest cockerel or the one not killed because at the farther end of the roost is likely to be the sire.

3. Competitive Shows.

The cattle shows which largely determine popular standards of desirability are primarily commercial, using standards fairly correlated with commercial values. A judge who has selected a poor milking Holstein or a Hereford which later shows a high percentage of offal is inclined to be apologetic. When the color standard of Jerseys seemed to be interfering with progress in milking qualities, it was modified.

The poultry shows which attract a great deal of popular attention and shape the ideals of the purchasing public use standards that have obviously low correlation with commercial value. Such shows and such standards for their own purpose are of course legitimate. But the lack of any equal influence making for commercial breeding has an unfortunate effect on the purchase of stock by the commercial poultry growers.

4. Performance Records.

The "advanced registry" of several breeds of cattle has given numerous, carefully guarded and collated performance records.

The fact that performance records of poultry are so few and unsubstantiated makes their collation hardly worth while.

5. Centgener Power.

With the attention paid to individuals and the data in the "registers," many cattle breeders are able to use a knowledge of this important factor in their breeding.

The dam of a chick is seldom known even by the fancier. Breeders can seldom furnish anything but a most fragmentary pedigree, and that is seldom asked for.

6. Performance Contests.

Performance contests are held not infrequently in the case of cattle. They are scientifically planned and executed, and their results receive wide publicity. In addition to gross production, cost of feed is recorded, thus giving net values as well, which are far more important considerations.

Performance contests of poultry are almost unknown in this country, though more prominent abroad. So far those held here have had little value, because of limited plans resulting from inadequate support.

Clearly these differences do not show excellent adaptations to the different materials worked with, but we have in the case of poultry serious difficulties. One of these is obvious enough: The keepers of poultry are a larger and less expert class than the keepers of cattle, because poultry is so often a minor consideration in a man's business. This will never be otherwise and a certain retardation of progress is inevitable. A more subtle but very important difficulty lies in the large body of active breeders whose stock has been built up almost solely under the ideals of the written "standards" in which utility is largely neglected. The poultry shows engaged in by these breeders are so large and prominent as to dominate commercial poultry breeding with the ideals of fancy poultry breeding in the absence of any counteracting influence. The extension of agricultural education is having an effect in awakening interest in utility breeding, but some important agency able to cope with the over-shadowing influence of

the poultry show, must be put into operation. Such an agency, I believe, would be a great national performance contest. The result can be only slowly attained if left to the initiative of periodicals and State Experiment Stations, and then in a less efficient and satisfactory way. It must be done more nearly on the plan of the St. Louis dairy contest, or still better, wholly divorced from private interests. It would be ideal if the American Breeders' Association could undertake such a contest; but, of course, lack of funds makes it necessary to appeal to our Department of Agriculture, which has already accomplished so much for animal improvement, largely through the efforts of our secretary. Such a stimulus would set scores of breeders to work at improving the utility values of all the breeds which show potentialities in this direction, would cause a wider distribution of stock of this quality, and would cause many of the poultrymen who sell for the market only, to practice such utility selection as may be feasible under their conditions. In short, it would have such an influence as the English country fairs had in building up so many famous breeds. Attention to this difference in the parallel I have drawn will therefore go far to remedy many of the other differences mentioned.

Certain modifications of current methods of laying contests seem desirable:

1. Individual records must be maintained and prizes awarded to leading individuals as well as to pens. Mass records alone would be scouted in nearly any other field of breeding.

2. Competition should be as open as possible. Discrimination between breeds should be avoided. If the number of entries must be reduced, it should be done on a basis of performance. It should be a competition between individuals and strains, not between breeds as such.

3. One set of prizes should be offered for the best net value of product and of gain in flesh per pen deducting cost of feed consumed.

4. Eventually such contests starting with eggs should be instituted where the entire profit from males as well as females will be involved.

After the Chairman had called attention to the program for the afternoon general session the association adjourned until 2 o'clock p. m.

WEDNESDAY FORENOON, JANUARY 16—SESSION OF THE PLANT SECTION.

On Wednesday morning the Plant Section of the American Breeders' Association met with the Ohio Plant Breeders Association and Ohio State Farmers' Institute in Chemical Hall.

The following report of the committee on breeding sugar crops was presented in part by Dr. C. O. Townsend:

REPORT OF THE COMMITTEE ON BREEDING SUGAR CROPS.

By Director A. D. SMITH, *Agricultural College, Mich.*

The sugar industry of the United States is dependent upon two crops for its support, the sugar cane and the sugar beet. The latter crop, growing as it does, in the cooler latitudes of the union, is an important factor in agriculture. Its success has been from the beginning problematical because growing the crop successfully involves a large amount of human labor and human labor is much cheaper in Europe than in America. To succeed at all the crop must have the very best seed as well as the most economical management of soil and labor. The American farmer can be trusted to bring about economy of labor through invention of new machinery and by such utilization of the labor offered him as to bring about the greatest results with the least expenditure. The matter of best seed is the one referred to this committee.

Various stations in the Union have taken up the breeding of sugar beet seed in cooperation with the Department of Agriculture at Washington. The Michigan Experiment Station has aided in this cooperation as far as its limited opportunities would permit. In the report of J. E. W. Tracy, hereto attached, there is given a full statement of the work done by all of these stations. Much study must be devoted to this question of breeding beet seed before the high ideals set forth by Mr. Tracy can be reached. The amount of labor involved in improving the seed is very large. The time of the chemist is required for the analysis of each mother beet and the expert plant breeder must, working with the chemist, determine whether a given beet, no matter how rich in sugar, shall be used as a mother or not.

The whole beet-growing and sugar-producing industry of Northern United States is interested in this question. Washington State is now sending east beet seed from mother beets secured through selection kept up for many generations. The results from this seed as reported in Michigan, have been very encouraging. Like good results have not yet been obtained from Michigan-grown seed.

BREEDING SUGAR BEETS FOR INCREASE OF SUGAR CONTENT AND YIELD.

By J. E. W. TRACY, *U. S. Department of Agriculture, Washington, D. C.*

IMPORTANCE OF USING HIGH-GRADE SEED.

The great importance of the quality of the sugar beet seed used, both to farmers and factories, can hardly be overestimated since both the percentage of sugar in the root and the yield of roots per acre are largely dependent upon it. In Germany, where the raising of sugar beet seed and the manufacture of sugar have probably reached their highest development, its importance is so thoroughly recognized that the most careful manufacturers insist upon having all the seed used by them grown under their own supervision and on such soils and under such climatic conditions as experience has shown to be best adapted to their particular localities. Here in America comparatively little attention is paid to this matter and consequently certain factories have been financial failures, largely, we believe, on account of negligence as to the actual character of the seed used. The reported extraction for all beets worked in the United States during 1905[1] was 11.74 per cent or 234.8 pounds of commercial sugar manufactured from each ton of roots worked. The extraction secured in Germany in recent years has been somewhat over 15 per cent, or between 3 and 4 per cent more than in America. It is not conservative to say that the average percentage of extraction in this country could be increased at least half of this difference, or say 2 per cent, by the use of as high-grade seed as is used by the Germans. Such an increase of 2 per cent of available sugar in the root would make a difference of 40 pounds of refined sugar to each ton of roots worked, which to a factory working 50,000 tons of beets per year would mean an increase of 2,000,000 pounds of marketable sugar. At this rate the total product of all the factories of the United States in 1905 would have been increased by more than 50,000 tons of refined sugar. Such an increase would mean the difference between profit and loss to many factories without any increase in the capital invested in their plants and with but a slight increase in the actual cost of production. Where a "flat rate," that is a uniform rate for all roots regardless of sugar content, is in vogue, there would be no additional expense for the roots; but where a "sliding scale" is used, the price paid depending upon the sugar content, an increase of 50 cents per ton for the roots would be incurred which, however, would go directly into the farmers' pockets at no additional cost to themselves. The cost of handling and slicing the roots and extracting the sugar would not be materially increased, the additional expense being in purifying and handling the finished product, both of which are comparatively inexpensive items in sugar manufacture.

[1] Figures for 1905 have been used throughout this article, since those for 1906 have not as yet been completed.

The difference in the cost of the best and the cheapest grades of seed is rarely more than 4 cents per pound, so that allowing 18 pounds per acre for planting, the additional seed expense would amount to but 72 cents per acre. The average yield of roots for the entire United States last year was 8.67 tons per acre, which with an increase of 2 per cent in available sugar would give an increase of 346.8 pounds of sugar per acre, worth say $16, at an additional cost of but 72 cents per acre for the seed. The total extra expense of seed for planting 10,000 acres, the area required for a 1,000-ton factory, would be $7,200, while the sugar output would be increased by 3,468,000 pounds, which, valued at 4½ cents per pound, would be worth $156,060.

It is thoroughly believed in Europe, and our experiments here have shown, that the yield of beets is also largely dependent upon the quality of the seed used. There is no doubt that the small yield of 8.67 tons per acre secured in the United States in 1905 could be greatly increased if only high-grade seed were used. Germany's average yield for recent years has been over 13 tons per acre, or more than 4 tons of roots per acre in excess of the American yield. If we estimate that, by using higher grade seed, our yield would be increased by but one-fourth of this difference or one ton to the acre, the yield in the United States would be increased by more than 300,000 tons, of which a 1,000-ton factory would receive 10,000 tons of roots. This would be the direct result of expending by such a factory, not to exceed $7,200 additional for high-grade seed. This additional yield would be directly beneficial not only to the factories, but especially to the farmers, who in 1905 would have received more than $1,500,000 additional for these roots, which would have been produced at practically no additional expense except for digging and hauling.

The United States Department of Agriculture has experiments under way to establish high-grade pedigree strains of seed for distribution to factories and seed growers, to determine the environmental influence of different sections on these strains, and to ascertain the comparative qualities of all varieties of sugar beet seed used in the United States, including both American and foreign sorts. This work has been established in connection with the New York Experiment Stations, at Geneva, N. Y.; the Michigan Experiment Station, Agricultural College, Mich.; the Utah Experiment Station, at Logan, Utah; and with individuals under Department supervision at Holland, Mich., and Fairfield, Wash.

THE ESTABLISHMENT OF PEDIGREE STRAINS OF SEED.

When this work was inaugurated the best strains of European seed obtainable, as well as all obtainable American sorts, were secured and planted side by side for comparison. The four sorts which showed the higher sugar content and purity and whose roots were most uniform and of best size, shape, color, etc., were decided upon for use as foundation stocks from which to breed superior strains of seed. Roots

from each of these stocks were individually analyzed and each one found to be of exceptional quality was carefully noted, numbered, and siloed for planting the coming spring as a mother. The seed from each of these mothers was harvested separately and in the following spring planted separately, and the products tested, the best being saved as foundation stocks for forming new families. These families were compared as to yield, sugar content, purity and correlated characteristics indicative of these qualities. Mother roots have since been selected from each of the families which have proven to be exceptional transmitters of their high qualities. During the past year we have raised some 1,400 pounds of seed from individually analyzed roots, testing from 18 to 24 per cent of sugar, depending upon the locality and the family. We also produced 20 acres of commercial seed which was grown from chemically analyzed grand-mothers testing 22 per cent. Both of these lots of seed will be used for experimental work during the coming year. It is the purpose of the Department, as soon as a superior strain of seed has been established and fixed, to supply growers and factories with a sufficient quantity to use as stock seed.

TESTING THE COMPARATIVE MERITS OF SUGAR BEET SEED.

The work of testing the various varieties of seed has progressed satisfactorily and has shown that in almost every instance the American-grown seed has proven superior to the imported seed, in that it was of stronger germinating qualities, produced a better stand of seed, gave a larger yield, and in most cases the beets were higher in sugar content. Our experiments have further shown that much of the imported seed is of questionable quality.

The beet-sugar industry is now so well established in the United States that it is poor policy to longer depend upon imported seed for there is always the possibility that on account of the failure of the European crop, or for political reasons, our European supply may be cut off, in which case the beet-sugar industry of America would be completely paralyzed. Even if this possibility is regarded as remote it is nevertheless true that the American beet-sugar factories can never obtain the maximum profit until their beet seed is produced to meet the peculiar American conditions of soil and climate. The Department aims to assist sugar-beet seed growers and factories in producing their own seed by not only supplying them with high-grade seed with which to begin operations, but to increase the sugar content and yielding qualities as well. The Department's work in determining in which locality sugar beet seed can profitably be grown and the environmental conditions affecting the quality of such seed will also, we believe, be of great assistance in thoroughly establishing this industry in America.

THE IMPROVEMENT OF SUGAR CANE BY SELECTION AND BREEDING.

By C. O. TOWNSEND, *Department of Agriculture, Washington, D. C.*

It is the purpose of this report to consider briefly the progress that has been made in the improvement of sugar cane in those countries in which this plant is grown commercially, and to establish if possible a general foundation upon which future reports may be based.

Sugar cane belongs to the natural order of grasses and is divided by Cordemoy into three species; namely, *Saccharum officinarum, Saccharum violaceum, and Saccharum sinense.* Most authorities agree that all cultivated canes are derived from the first species named. The second one is found in Hawaii, while the third is the Chinese cane. At each joint and underneath the leaf is the bud or eye, which was thought for many years to be the only means by which cane could be propagated and which is still the principal means of propagating this plant commercially. This bud is about the size of a pea or a little larger, and varies in size and shape on different canes. The head of the cane, commonly called the arrow, consists of large white or gray clusters of flowers, a panicle of soft silky spikelets carried on an elongated peduncle. The spikelets are made up of three scale leaves, two exterior and one interior. The two outer ones are called the glumes and the interior one the palea. Within this covering is the flower, consisting of three stamens and one pistil. The ovary is ovoid and sessile, and contains only one ovule. It carries two styles of a reddish color, which in turn carry a large number of stigmas. The time of flowering varies from eight to fifteen months, but the cane is not fully ripe until from two to three months after flowering.

The composition of sugar cane varies with the species and with the conditions of growth. The limits of composition of cane as given by Dr. Deerr in his work on Sugar and Sugar Cane is as follows:

	Per cent.
Water	69 to 75
Sugar	10 to 18
Glucose	0 to 2
Fiber	8 to 16
Ash	3.10 to 8.10
Organic non-sugar	½ to 1

What is here called fiber refers to the insoluble matter and not alone to true cellulose.

One of the strongest incentives to the improvement of the quality of sugar cane has been the development of its rival as a sugar plant—the sugar beet. It is therefore only within comparatively recent years that earnest systematic efforts have been made to improve cane as a sugar-producing plant.

Two general methods have been employed in improving the size,

quality and habits of sugar cane. One method may be designated as vegetative or bud selection, and the other as breeding. The former undoubtedly has been carried on by cane growers either consciously or unconsciously from the time this plant was found to be of economic value, even without having in mind a definite type of cane to be produced. Vegetative selection is based upon bud variation, in which peculiar or desirable characters have been recognized by the grower; as for example, size of cane, color, ability to stand erect, size of nodes, length of internodes, ability to ratoon, etc. Some effort has been made to improve cane by chemical selection, and, while considerable progress has undoubtedly been made along this line, it has been largely because the desirable internal qualities of cane correspond to some extent with the desirable external qualities. The difficuties in the way of chemical selection under the vegetative plan of breeding are similar to those of other plants. The soil and climatic conditions, as well as methods of cultivation, cause considerable variation in the sugar content of the cane. As an instance of the variation in sugar content due to external conditions it is stated that the crop in Demerara in 1900 consisted of one variety only. The canes grown on virgin soil contained less than eleven per cent sugar while the same variety growing on older land produced fourteen per cent or more. This fact has been observed repeatedly in connection with sugar beets, and it is undoubtedly a general rule that the composition of the plant varies within wide limits depending upon soil and climatic conditions. Likewise the part of the cane tested as well as the age of the cane causes variation in the results obtained. The lower part of the cane for example contains considerably more sugar and less glucose than the upper part. The following data from a table prepared by Bonane establishes this fact.

A. Plant imperfectly ripe and still in full vegetation. The lower part contained 13.74 per cent of sugar and 1.78 per cent of glucose; the middle part contained 14.11 per cent of sugar and 2.44 per cent of glucose; the upper part contained .85 per cent of sugar and 4.11 per cent of glucose; and the white top contained 4.01 per cent of sugar and 6.57 per cent of glucose.

F. Plant very ripe, 14 months old. The lowest fourth contained 22.68 per cent of sugar and .51 per cent of glucose. The lower middle fourth contained 22.68 per cent of sugar and .52 per cent of glucose; the upper middle fourth contained 22.68 per cent of sugar and .52 per cent of glucose; the upper fourth contained 22.03 per cent of sugar and .53 per cent of glucose; and the white top contained 16.84 per cent of sugar and .70 per cent of glucose.

The other plants used by Bonane were mostly ratoons, which showed a marked decrease in the sugar from the base upwards and a corresponding increase in glucose. It is important therefore in comparing canes for the purpose of establishing a higher sugar content that the sample be taken from the same part of each cane tested. It has been ascertained that over-ripe canes rapidly deteriorate, hence the exact time of making the test is important. Inasmuch as different varieties of cane ripen at different ages, it is difficult to make tests that

are comparable, and especially is this true since the latter ripening variety may be subjected to weather conditions during the ripening period that are entirely different from the weather conditions that obtained while the earlier varieties were ripening. It is also true that the buds on the lower nodes of the cane are less active than those at the upper nodes. For these reasons it is customary in some localities to use the upper three or four nodes for planting, while the lower part of the cane is used for sugar production. Whether or not the practice of using buds from that part of the cane poorest in sugar and richest in glucose will not eventually cause the canes to deteriorate can not be determined from any of the reports examined. The fact that the buds are practically independent of the canes so far as germination and growth are concerned would lead to the conclusion that the quality of the cane produced from the bud would be but slightly influenced by the quality of the cane upon which the bud was borne. This can be determined with certainty only upon investigation.

The improvement of cane by seminal breeding has been confined to the past two decades. For many years it was supposed that the seed of cane was infertile. Although we find some references to the production of seedling canes in India, no importance was attached to these statements by cane producers. Darwin, in his work on the variation of animals and plants under domestication, cites cane as one of the plants which does not produce seed. He bases this statement upon the record of various observers in the principal sugar countries of the world. De Candolle in his Origin of Cultivated Plants states that the seed of cane has never been described nor figured. For the reason stated, the buds on the joints of cane were considered the seeds of this plant and were, as already stated, looked upon as the only means of reproduction. In 1858 it was found by J. W. Parris, of Barbados, and in 1860 and 1861 by F. B. Carter, of that Island, that a few of the seeds produced by sugar cane were fertile, but they were so few in number and the difficulties that arose in trying to produce canes from seeds were so great that the idea was abandoned. It seemed to be the purpose of those who discovered fertile seeds in early days to do something in the way of producing commercial cane from seeds, while very little attention seems to have been given to the production of improved strains or varieties at that time by seminal variation. In 1887 fertile seeds of sugar cane were again discovered almost simultaneously by Professor Soltwedel, Director of the Samarang Station in Java, and by Mr. J. B. Harrison, Island Professor of Chemistry and Agricultural Science at Barbados, in conjunction with Mr. T. R. Bovell, Superintendent of Dodd's Reformatory. The flowers of cane were figured by Professor Soltwedel probably for the first time, and it is claimed by some writers that his discovery of fertile seed and the production of seedling canes therefrom slightly antedates the discovery of Messrs. Harrison and Bovell. The two investigators last mentioned, however, made the most practical use of this discovery, or rather rediscovery of fertile seeds of cane. The method of their discovery is briefly as follows: The canes were planted in thirty-six

plats of eighteen varieties, so arranged that two sets of each kind were planted side by side. The plats were noticeable for the number of arrows sent up by some of the varieties. Mr. Harrison gave strict orders to the laborers to call his attention to any peculiar or unusual grasses that appeared among the canes during the season. Accordingly his attention was called to a few tufts of grass toward the end of January. He states in his report that a great deal of difficulty was experienced in keeping these plants alive as the quickly shriveled under the influence of the sun's rays. However, by keeping them shaded and constantly watered he succeeded in saving upwards of sixty of the plants. This probably is the beginning of the breeding of sugar cane, at least so far as we have any record of this phenomenon.

In 1887 Dr. Soltwedel tried to cross one of the cultivated varieties with one of the wild kinds. It was not possible to ascertain whether or not the cross fertilization was successful. Fertilization was observed in twenty varieties of cane other than the variety used, and fertile seed was produced in eleven of these varieties. The number of seeds produced varied from thirty-one per cent to less than ¼ of one per cent. A very large number of Dr. Soltwedel's seedlings perished. In fact he obtained strong seedlings from only one variety, the Yellow Hawaii. These attained a height of 2¼ meters. The fact that Dr. Soltwedel and Messrs. Harrison and Bovell worked independently upon this interesting problem and obtained practically identical results would lead us to the conclusion that both parties are entitled to great credit for this discovery, which undoubtedly means much for the future of the cane industry.

The principal difficulties in the way of the improvement of sugar cane either by vegetative selection or breeding are due to several general conditions, such as confusion of names, non-stability of characters, and size and position of flowers. The confusion of names of existing varieties is due in part to our lack of knowledge of the origin of cane and in part to the tendency on the part of planters to give old varieties new names when they are introduced into new localities. Some writers claim that the original home of the cane is China; others find strong evidence that it originated in India, while still others claim that it is a native of the Pacific Islands. Without the original type plant we are unable to determine what are variations and what are true characters. Again a cane introduced into Louisiana from Hawaii, for example, may receive in Louisiana the name of the planter who first grew it. If taken to Queensland, it may receive still another name, all of which tends toward great confusion in regard to the true name and to the number of existing varieties.

As has already been indicated, it is difficult to fix upon any characters which may be sufficiently stable to establish a basis for varieties. Among the important points toward which cane breeders aim may be mentioned the following: (1) Good yield. (2) High sugar content. (3) Upright growth. (4) High fertility. (5) Freedom from disease. (6) Fair fiber in megass. (7) High percentage of juice. (8) Early maturity. (9) Ease of crushing. (10) Easy clarifica-

tion of juice. (11) Flinty rind. (12) Satisfactory ratooning. These characters may all be summed up in the one statement that the cane most desired is the one that will yield the largest quantity of sugar per acre with the greatest certainty and with the least expense. The value of nearly all these characters is self-evident. It is of prime importance that a good yield of cane rich in sugar be produced. A tendency in the cane to fall down produces not only crooked canes that are hard to handle, but canes that are low in sugar and rich in glucose. The fiber in the megass is of special importance in those localities where this material is used as fuel.

One of the most common characters which has been used to distinguish varieties is that of color. To this have been added size of nodes, length of internodes, general character of arrows, and habit of growth. In regard to color as a varietal distinction, Professor Stubbs in his work on the cultivation of sugar cane divides all the varieties found in Louisiana into three classes according to color. In the first class he places all white, green and yellow canes; in the second class, all the striped canes; and in the third class, canes having solid colors other than in class one. He then divides the canes under the varietal classes into groups, the number of canes in each group varying from one to nine. All the members of the same group are, according to Professor Stubbs, identical. Whether or not canes retain their color under the various soil and climatic conditions in Louisiana, Professor Stubbs does not state, but according to Professor Eckart color is not a staple character, at least with some varieties. He has made a study of a large number of varieties, and states that between White Bamboo and Yellow Caledonia there seems to be no difference and after four years trial it is impossible to distinguish one from the other. This arrangement by Professor Stubbs is made for the purpose of bringing order out of chaos regarding the names of the varieties of cane. Several years ago the Louisiana Station inaugurated a plan whereby the different varieties of cane grown in various countries could be exchanged and compared for the purpose of determining which are identical. This will undoubtedly do much toward solving the problem of varieties, providing the influence of soil and climate has not already produced marked changes in the imported varieties so that they can no longer be recognized as belonging to the type from which they originated.

In conclusion it may be said that much has been accomplished in improving sugar cane in spite of the many difficulties and discouragements that attend the selection and breeding of this important plant. Not only has the yield of sugar per acre been greatly increased, both by increased yield of cane and by a higher sugar content, but varieties more or less resistant to disease have been produced, thus making the crop more profitable and more certain. Furthermore, varieties suited to different soil and climatic conditions have in some instances been developed in this manner, greatly increasing the acreage. That much may still be done to improve the quality of sugar cane and the quantity that may be produced per acre is certain, but it will take years of

patient painstaking work to approach the desired goal. In our own country much has been accomplished by the Louisiana Experiment Station. It has not been possible in this country to produce canes from home grown seed owing to the fact that cane grown in this country does not produce fertile seeds. Imported seeds have produced canes some of which are very promising along several lines of improvement. In Java a great deal has been accomplished in producing canes immune to disease as well as in producing improvements along other lines. Likewise in Australia, Hawaii, and other sugar-producing countries, the methods of improving sugar cane have been inaugurated along right lines, and the future is full of promise for good results. The most satisfactory results have been attained in the British West Indies, where improvement by seminal variation was first successfully started and where it has been carried on continuously for nearly twenty years. While the vast majority of seedlings produced have been rejected for good reasons, a few have been more or less satisfactory, and are now being grown in nearly all cane-growing countries of the world. The methods of selecting and hybridizing are fully described in Professor Stockdale's report of last year.

Mr. C. G. Williams, of the Ohio Experiment Station at Wooster, presented the following paper:

CORN BREEDING AND REGISTRATION.

By C. G. WILLIAMS, *Wooster, Ohio.*

The basis upon which corn breeding and registration rests is the ear-row test. This test, when wisely and carefully conducted, is a very satisfactory method of determining the comparative yielding ability of ears of corn. In making one's selection of ears for this test it is probable that some time and labor may be saved, i. e. some ears of little value be kept out of the test, if the selections are made as the corn is ripening in the field.

Good ears of corn are what they are as a result of either heredity or environment. Selected apart from the growing plant, the chances for choosing ears, which owe their excellence to heredity, are not the best. Most especially productive plants owe their superiority to immediate environment. Extra food, sunlight, and moisture, resulting from the thin stands, are responsible for many more large ears of corn than is heredity. When selections are confined to the best plants and ears obtainable, which have been grown under normal environment, a pronounced step is taken in the direction of sifting out the temporarily and accidentally good from the inheritably good. "Natural selection," De Vries tells us, "is a sieve." So is all selection.

GERMINATION.

Several weeks in advance of planting, all candidates for the ear-row plat should be given a germination test. With early selection and wise handling of seed ears, however, there is little weeding out likely to be accomplished in this way.

RECORDS.

It is well to record quite minute details as to the characters of the ears going into the test, and of the mother plants as well. Such data may prove exceedingly valuable in making correlations, when we have accumulated enough of them. I hesitate to burden this paper with the enumeration of some seventy different headings, under which we aim to record data, beginning with the mother plant in the field the year previous, and ending with the harvest of the ear-row test. I must not, however, fail to mention the photographing of each ear tested.

PLANTING.

The ear-row test may be planted without any regard to other corn fields. A convenient place may usually be found in connection with the general crop field. The important thing in locating this plat is the selection of soil of uniform fertility, level or of uniform slope, and so laying it off that all rows shall be equally affected by tile drains, surface ditches, dead furrows, etc. This is more easily said than done upon many Ohio farms. If it could be carried out with absolute exactness, an absolute reliable test would result. Differences in yield which were then found could, if subsequent work were as carefully conducted, be ascribed to heredity. But practically it is not possible to do all this. Some known and very many unknown differences exist—differences which make it exceedingly difficult to distinguish as between hereditary merit and environment results. Our experience, both at the station and in our cooperative work with corn breeders in various parts of the State, has convinced us of the value of the duplication of the ear-row test and the use of the uniform check row.

The method of planting a duplicate ear-row test, having uniform check rows, is as follows: Assuming, for convenience, that 25 ears are going into the test; 61 rows will be required, 11 of which will be checks. Beginning with a check, every sixth row throughout the test plat will be planted as a check.

In planting the check rows, the number of ears necessary having been determined, they are shelled and kept separate and the same number of hills (and kernels) planted from each check ear upon each check row. Between each pair of checks are 5 rows, making 50 rows in all, numbered from 1 to 50, exclusive of the checks. These 50 rows are planted with the 25 ears to be tested, 2 rows from each ear, rows 1 and 26 being planted from ear 1, 2, and 27 from ear 2, 28 from ear 3, and so on. The rows are usually 50 hills in length.

It is not necessary, however, that the duplicate series be planted

immediately alongside the original. It may be taken to another part of the farm.

It yet remains to call attention to the great desirability of growing and harvesting the same number of plants on each row. With 100 plants in one 50-hill row and 175 in another we have unnecessarily increased the difficulty of arriving at correct conclusions.

The germination test will not always save us from an uneven stand, for the fact that an ear of corn has shown perfect germination, as ordinarily tested, is by no means proof that every kernel will grow

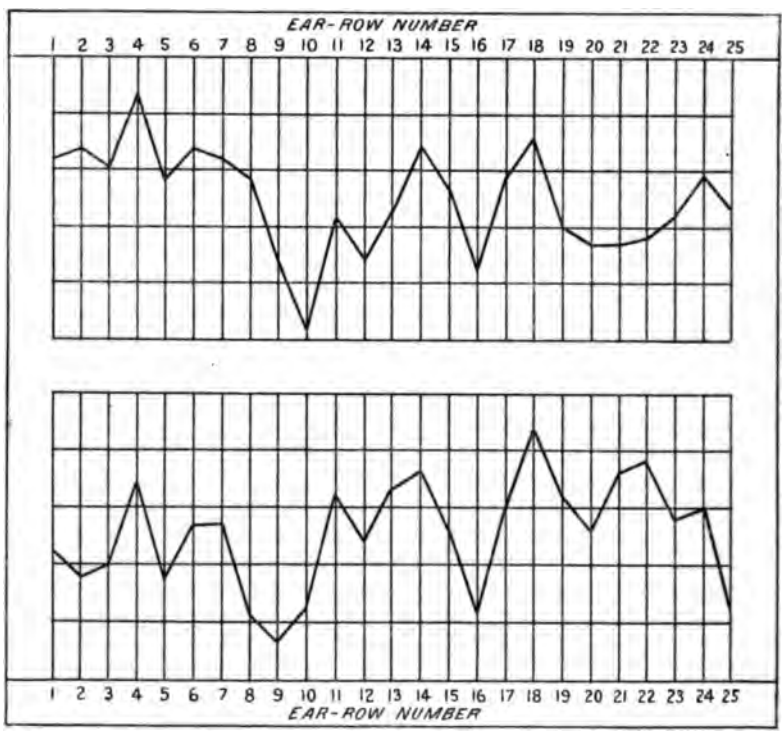


CHART 1.—Ear-row test. O. W. Erven, Henry Co., O., 1905.

under unfavorable field conditions. In order to be able to thin a uniform stand of plants per hill after the losses from bad weather, insects, birds, etc., are over, and the corn 6 to 8 inches high, it will be found necessary to plant liberally. The planting is, of course, uniform throughout the test. Usually from one-half to two-thirds of the seed grain of each ear is used in planting the two rows of 50 hills each, the balance of the seed of each ear being carefully saved in a small sack bearing the same number as the ear, for possible future use.

Data are recorded, as the season progresses, regarding the number

of plants coming up in each row, rapidity of early growth, proportion of leaves, character of leaves, date of tasseling, date of silking, height of plants, height of ears, number of smut masses, number of broken plants, number of barren plants, number of useless plants, number of plants with two or more ears, number of suckers, date of ripening, total number of plants harvested, etc.

Each row is harvested separately, the weight of the marketable and unmarketable corn is determined, and the comparative rank of the mother ears as to yield is established.

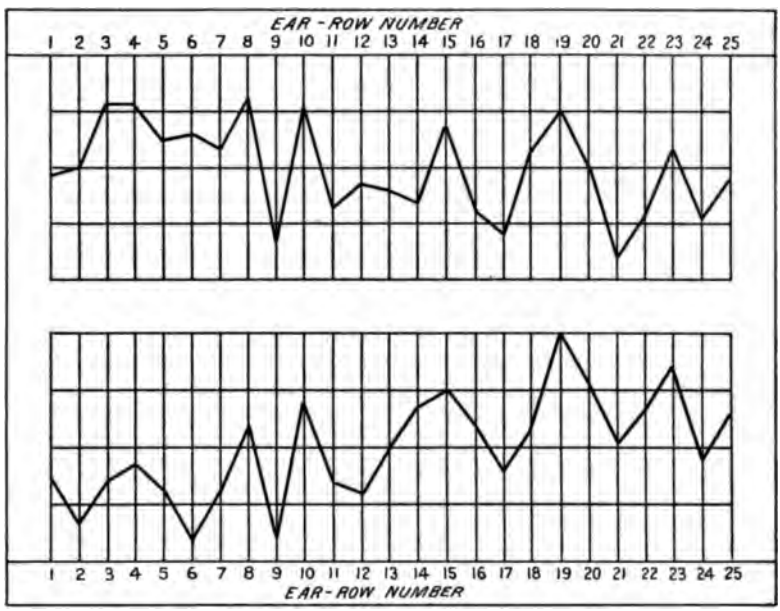


CHART 2.—Ear-row test. L. H. Goddard, Fayette Co., O., 1905.

SOME RESULTS OF CORN-BREEDING WORK IN OHIO.

You may be interested in looking at a few curves, showing the results secured by some of the members of our Ohio Plant Breeders Association, and especially the bearing of the duplication of the work upon the selection of high-yielding ears.

CHART 1.—We have here curves showing the comparative yields of a duplicate ear-row test conducted by O. W. Erven of Henry County, Ohio, in 1905. Basing the selection on the upper curve, you note that ears 4, 2, 18, and 14 would be chosen; based upon the lower curve, ears 18, 22, 21, and 14. It is evident that selections based upon either curve by itself (and this would have to be done but for the duplicate) will hardly be as satisfactory as selections based upon both. Averaging the curves, ears 18, 4, 14, and 22 rank highest.

CHART 2.—We have here a test conducted by L. H. Goddard, of Fayette County, in 1905, in which the plants were greatly injured by wet weather and the test probably would have been abandoned had it not been for the duplication. You will note that the first curve tends downward, while the second curve, planted from the same ears and in the same order, tends decidedly upward. The two series were planted side by side. The ground being slightly lower in the center, two weeks of continuous rain coming at a critical period, seriously injured the

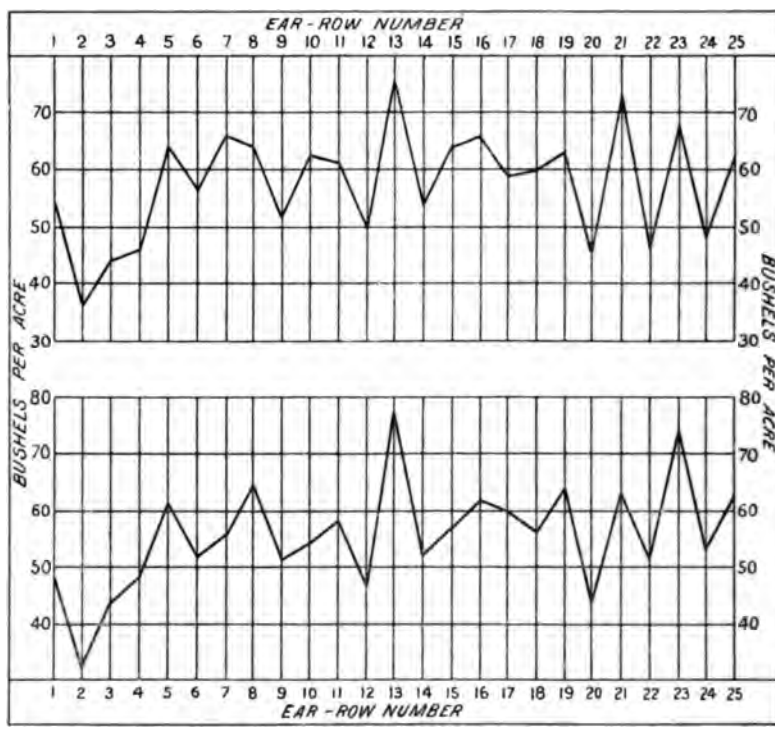


CHART 3.—Ear-row test. F. C. Snyder, Sandusky, O., 1904.

rows represented by the right of the upper curve and the left of the lower. Taking the two curves together it is not very difficult to locate the three or four ears which were of much higher grade than the others.

CHART 3.—In Chart 3 we have represented the work of F. C. Snyder, of Sandusky County—an ear-row test conducted in 1904. These curves give evidence of careful work and very even ground. The verdict of the first series is in favor of ears 13, 21, 23, and 7; of the second series, 13, 23, 8, and 19 or 21. The chances of making mistakes here without duplication are less than in either of the others shown, yet even here I think we gain something by the duplication.

CHART 4.—On this chart we have shown a test in which the check row was used. This check row serves to show some uneveness in the environment but fails to account for the two radical variations observed in ears 4 and 17. Without duplication the first series would

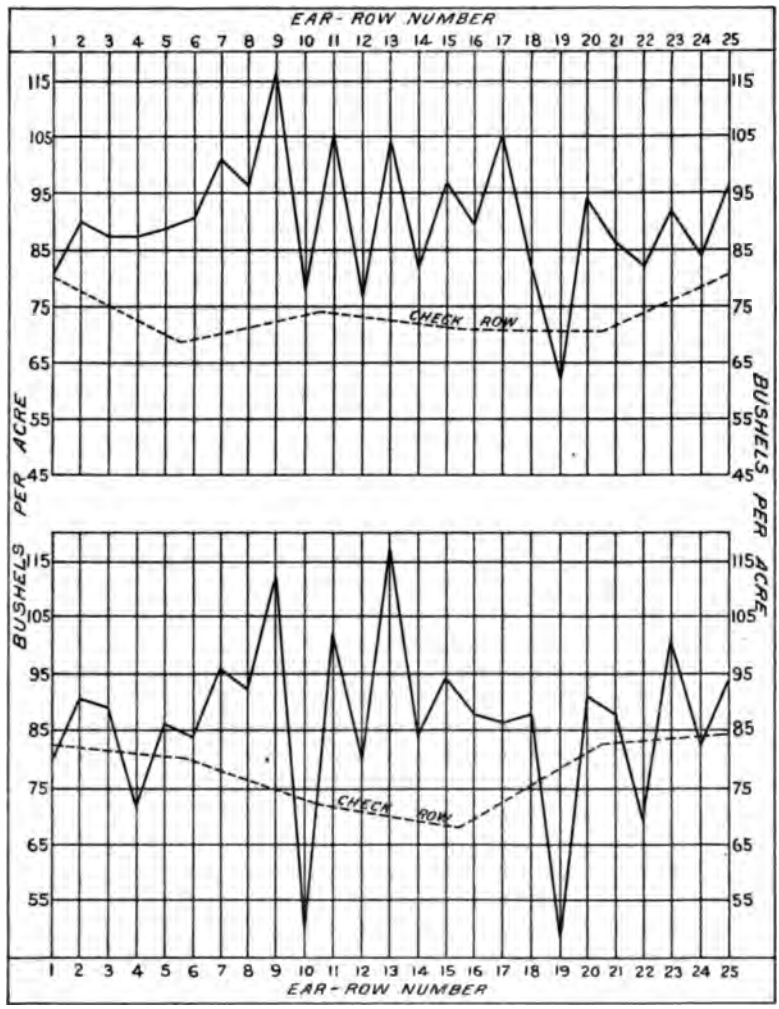


CHART 4.—Ear-row test. O. A. E. S., 1905.

have elected ear 17 to the select circle, but the second series vetoes this. Ear 23, which stands fourth in the second series, occupies a much inferior position in the first series; while ear 7, which stands fifth in each, will, on the average of both, take fourth place.

CHART 5.—J. W. Cook, of Hancock County, has a test this year in which the value of duplication is quite apparent even when a uniform check row is used. In this test you will note that the check rows show a surprising uniformity in the very moderate lack of uniformity in the two series. This test shows two mountain peaks of about the same comparative height above the check in both series—rows 5 and 21. In addition it shows something which I will not undertake to explain, although it is exceedingly important that we find out the course; viz, two valleys in the first series—12 and 19—changed to mountains in the second series.

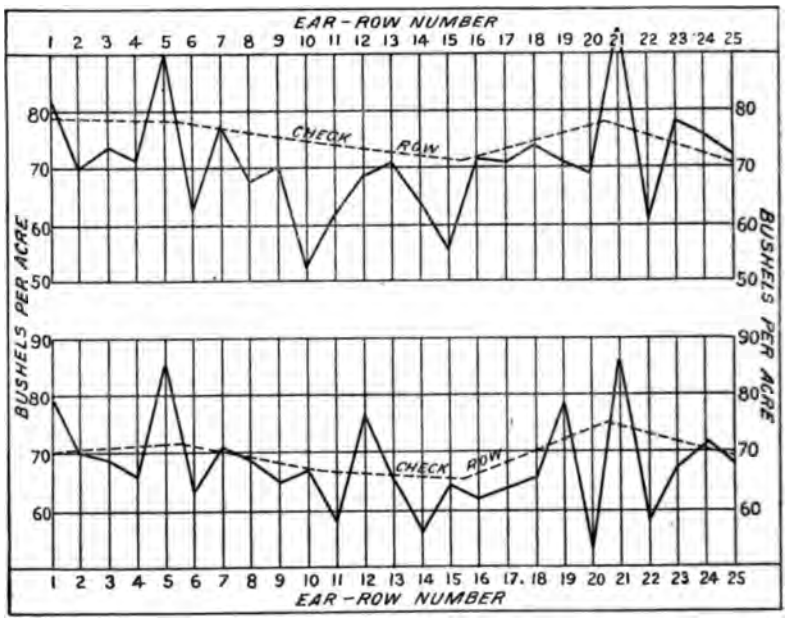


CHART 5.—Ear-row test. J. W. Cook, Hancock Co., O., 1906.

I should care to save seed seed from only three ears in this test, but from 21, 5, and 1, I should expect good results.

It should be said, perhaps, that the difference in yield of ear 12 in the two series was not due to stand. There was one more plant harvested in the first series than in the second. Neither are the wide differences in yield which you observe, as for instance in the rows planted from ear 21 as compared with 10, due to number of plants harvested, for there were five more plants harvested on 10 than on 21. The differences between these ears, I believe, are results of inherent quality, not of environment.

PERPETUATION OF IMPROVEMENT THROUGH BREEDING.

It would seem quite evident that the ear-row test furnishes a means of selecting ears of inherent value. Having discovered such ears the question now confronting us is: "How may they be perpetuated with greatest advantage?"

Two methods are in use. In the first, selections of choice ears are made directly from the ear-row test. Certain seed ears having demonstrated their ability as producers, their progeny is selected directly from the row, subject of course, to more or less cross pollination from much less desirable ears.

In the second, recourse is had to the original remnants of the ears, as planted in the test. The test having shown which are the high-yielding ears, their breeding is thus made possible. Accordingly the following season the best of them are crossed in an isolated breeding plat. This breeding plat is made up of a number of short rows from each ear remnant used, one only being used as sire (when natural pollination is permitted), with several others as dams. The ear remnant used as sire is planted upon each alternate row. The ear remnants used as dams are planted separately, alternating with the sire rows. The latter are the only plants allowed to mature pollen. In this way several distinct strains may be grown in breeding plat, all having, of course, the same sire—strains having a performance record for both sire and dam.

The theoretical advantage of this second method of breeding is being accepted by some breeders. The actual demonstration of its value will require several years yet, although evidence in its favor is gradually accumulating. For instance, we had this year at the Ohio Station tenth-acre plats of corn growing in our variety corn test, illustrating both methods of breeding. In one we used a strain of Leaming corn, bred by our Mr. F. C. Snyder, of Sandusky County, who had crossed (merged) the remnants of the best ears of his 1904 ear-row test, in an isolated breeding plat in 1905, and furnished us seed for tenth-acre plats of both his original Leaming corn and his proposed new "Ohio Standard Leaming" (as our Ohio Plant Breeders' Association styles it). These plats were grown side by side and between our regular variety check plats. The Ohio Standard Leaming gave a yield of 7.17 bushels per acre in excess of the original Leaming from which it had been selected.

In the same tenth-acre plat test we had two plats planted in what I will call "half-blood" strains of Clarage corn selected directly from the highest rows of an ear-row test, in which greater superiority was shown on the maternal side than in the case of the Leaming just quoted. These "half-blood" strains were grown by the side of the original stock from which they had been selected and gave an average gain of 2.8 bushels per acre. In other words, the standard-bred strain, in the breeding of which, pollen from the inferior ears of the ear-row test had been eliminated, gave a gain in excess of the "half-blood" strains of over 150 per cent.

PLAN FOR CONTINUOUS CORN BREEDING.

I wish now to call the attention of the Association to a plan for continuous corn breeding work which the Ohio Station is following. (See Chart 6.) The first year's work consists of the selection of ears for the ear-row test from the general crop. These ears are given a duplicate ear-row test the following season; and the third year, the remnants of the highest yielding ears of the ear-row test of the second year, are crossed in the breeding plat. The fourth year a portion of the stock of registered ears will be merged and go into the multiplying plat and the fifth year into the general field crop.

Each year will have its own ear-row test, the ears tested in the ear-row test of the third year all coming, as before, from the general crop. In the ear-row test, conducted the fourth year of the work, registered ears from the third year's breeding plat meet the selections from the general crop by the same year. One is thus enabled to test out the results of his breeding work to date. No pedigreed ear is carried from one breeding plat to another simply on the reputation of its parents. These registered ears must go back to the ear-row test, climb the high fence, and, if they succeed, they will be found in the breeding plat of the fifth year. No ear gets into any breeding plat in this system of breeding which has not demonstrated its worth. Of every ear produced in any breeding plat, it is possible not only to name the sire and dam, but give the performance record of sire and dam, and that record, comparatively speaking, must be a good one. Take for instance the breeding plat of the eighth year. Of some of the ears found in this plat it will be possible to give the performance record of the sire and dam as tested in the ear-row test of the seventh year; of the grand-sire and grand-dam as tested in the ear-row test of the fifth year and of the great grand-sire and dam as tested in the ear-row test of the third year; and if there are other ears there with a shorter pedigree it will be because they have demonstrated their superiority over those of a longer pedigree.

As the work continues the ear-row test will draw upon the multiplying plats for ears for testing, and, after the fifth year, from a general crop which has descended from pedigreed ears.

DANGERS FROM IN-BREEDING.

But what about the dangers from in-breeding in this system? We do no detasseling in the ear-row test plats. Less than one-sixth of the parent ears represented in any one ear-row test will ever be used for breeding purposes, and which these ears are we do not know until the test is completed. The place to secure cross-breeding of the ears we want cross-bred seems to be in the comparatively small breeding plat where we can cross intelligently and without detasseling large numbers of plants we really have no use for.

The ears leaving the breeding plat of the third year's work will certainly be as thoroughly cross-bred as ears selected directly from

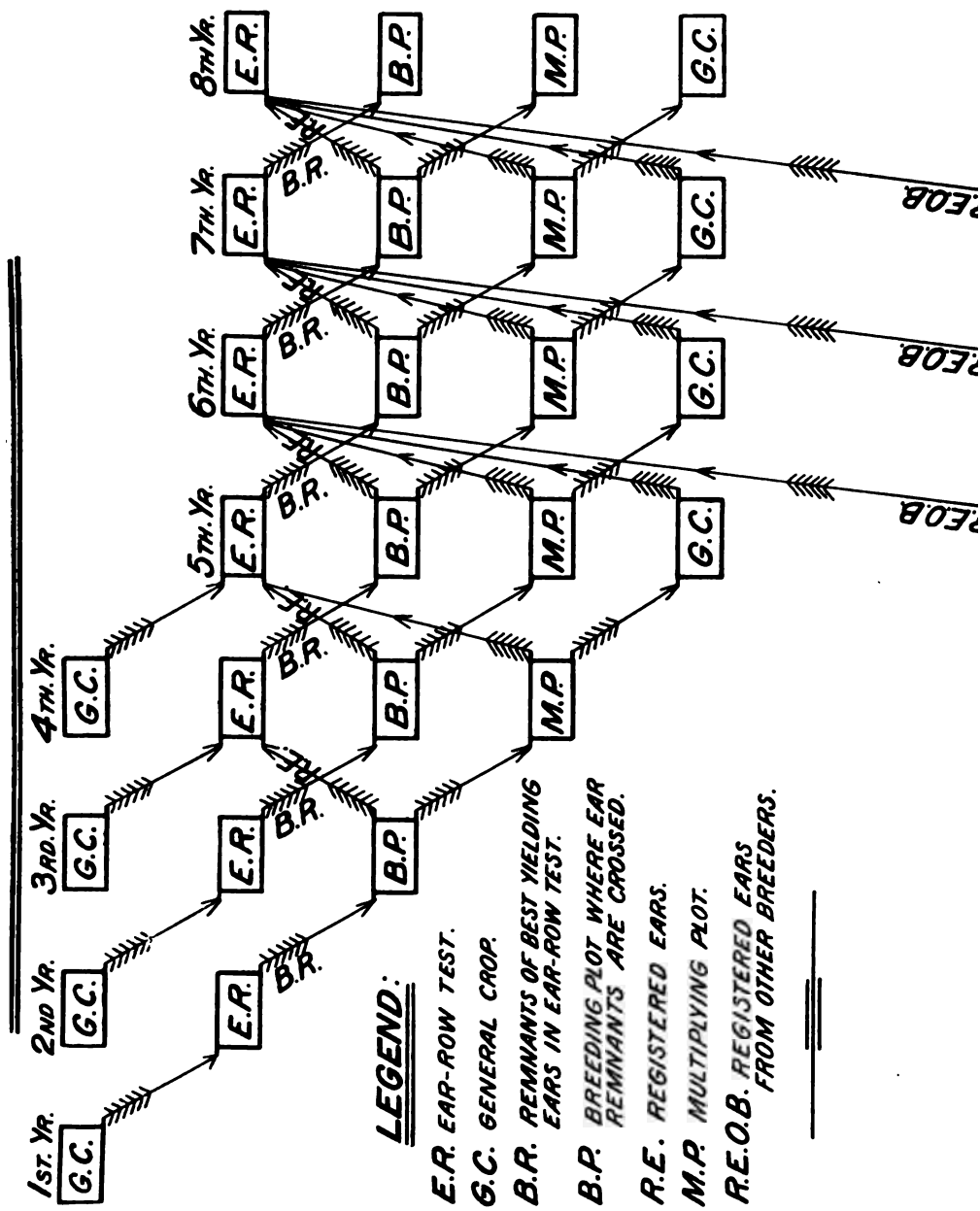

1ST. YR.
2ND YR.
3RD. YR.
4TH. YR.
5TH. YR.
6TH. YR.
7TH. YR.
8TH YR.
G.C.
E.R.
B.R.
B.P.
M.P.
R.E.O.B.
LEGEND:
E.R. EAR-ROW TEST.
G.C. GENERAL CROP.
B.R. REMNANTS OF BEST YIELDING EARS IN EAR-ROW TEST.
B.P. BREEDING PLOT WHERE EAR REMNANTS ARE CROSSED.
R.E. REGISTERED EARS.
M.P. MULTIPLYING PLOT.
R.E.O.B. REGISTERED EARS FROM OTHER BREEDERS.

CHART 6.

the general crop. In the latter case we would have good reason only to believe that they were cross-bred; in the former case we know it. These ears will meet ears from the general crop in the ear-row test of the fourth year's work, and our experience is that some of these new selections will prove worthy competitors of the pedigreed ears.

In our first selections for ear-row testing we chose perhops 100 ears from a crop of a third of a million ears. It is hardly probable that we secured all the good ones. It is probable that in our successive selections we shall get, not only new, but worthy blood which will work its way into the breeding plat.

There seems to me to be no possibility of any trouble from in-breeding before the sixth year; the ear-row test of this year being the first which draws ears from a general crop which has descended from pedigreed strains, but even then it is very doubtful for we have three distinct lines of breeding converging into the ear-row plat of this year, as follows: (1) The general crop of the fifth year, which has descended from the first year's selection; the multiplying plat of the fifth year, which has descended from the second year's selections; and the breeding plat of the fifth year, which has descended, in part, from the third year's selections and has been thoroughly cross-bred as well. This would seem to provide pretty well against in-breeding. But be this as it may, if in-breeding is feared at this time, or later, there is nothing to hinder our corn breeder from following the custom of the animal breeder. He can go to another breeder, who is breeding corn similar to his own, for new blood. And he can do this with greater safety than the animal breeder for the latter, when he purchases a sire, has no recourse but to use him; to incorporate the new blood into his herd and anxiously wait to see what value it may possess. Whereas the corn breeder can test the producing ability of the registered ears he would use from other breeders, beside his own corn in the ear-row test, and if it prove inferior to his own corn he can drop it without any contamination. If it prove the equal of his own, or better, the following year it will go into the breeding plat. New blood may be introduced as frequently as may prove necessary.

ISOLATION OF PLATS.

One of the difficulties confronting the corn breeder is the isolation of breeding plats. A system of breeding which called for a large number of isolated plats would be objectionable. The chart before you is pretty well covered with corn fields, but as a matter of fact, the only plats calling for isolation are the breeding and multiplying plats, and with some of our smaller growers the multiplying plats will naturally take the place of the general crop. In such cases only one isolated plat will be required each year.

REGISTRATION.

Ohio corn breeders came to a point two years ago when they realized that some system of registration was needed which should do for corn breeders what the so-called system of advanced registry is doing for

some of our dairy-cattle associations, a system of registration which would certify both as to ancestry —including, of course, both sire and dam—and performance records. A committee was appointed to devise such a system, of which Mr. L. H. Goddard was chairman. This committee carefully studied the systems of our various live-stock registry associations and later recommended the following rules, which were adopted by the Ohio Plant Breeders' Association at their annual meeting one year ago. They are as follows:

RULES FOR THE REGISTRATION OF SEED CORN WITH THE OHIO PLANT BREEDERS' ASSOCIATION.

Section 1—Eligibility.

In order that a strain of corn may be eligible to registry with the Ohio Plant Breeders' Association, it is necessary that it trace directly and exclusively to remnants of ears that have ranked not lower than fourth in point of yield of grain, protein, starch, or fat in a duplicate ear-row test of not less than 25 ears, or in like proportion with a larger number of ears; and that each year's breeding or testing work shall have been conducted and recorded in accordance with the requirements of the Association.

Section 2—Ohio Pedigreed Corn.

Any corn which is the product of a cross between two-ear remnants, one as sire and the other as dam, each of which has been selected as per Section 1, shall be entitled to the name "Ohio Pedigreed." The records shall show whether the cross was made by artificial or natural pollination.

Section 3—Ohio Standard Corn.

Eight or more registered ears, as per Section 2, or ear remnants as per Section 1, may be merged by shelling and mixing together the grain from all, before planting. If this merged corn, or corn descended exclusively from it, shall on the average, excel in yield of grain, protein, starch, or fat per acre, each of three other varieties (including the one from which it has descended and a standard variety which shall be supplied by the Council upon request) when tested upon not less than tenth-acre plats for three consecutive years, the owner of it shall be entitled to a certificate under the seal of the Association, setting forth the record numbers under which the work upon this corn has been recorded, together with a statement that it has filled the requirements of the Association and is entitled to the name "Ohio Standard."

A fee of $10 shall be required for this certificate and copies of same shall be issued at 25 cents each to accompany any corn that traces directly and exclusively to this merging.

Section 4—Transfers.

Transfers of grain, together with all breeding privileges, may be made at any time, but in order that the progeny of such grain may be eligible to registry with the Association, each transfer must be entered for registry with the recording secretary of the Association within three months of the time of transfer. A certificate of transfer shall then be issued under the seal of the Association showing the record numbers under which the work of the breeders upon this corn has been recorded. A fee of $1 shall be charged for each record of transfer.

These rules provide for the registry of two different sorts of corn, called Ohio Pedigreed and Ohio Standard. The Pedigreed corn

(referring to the "continuous corn breeding chart") is produced in the annual breeding plats and nowhere else. The Ohio Standard corn is produced in the multiplying plats, and, beginning with the fifth year, in the general crop. Before it is entitled to the name and certificate of Ohio Standard it must prove its worth in three consecutive competitive tests.

WEDNESDAY AFTERNOON, JANUARY 16—GENERAL SESSION.

The American Breeders' Association met with the Ohio State Farmers' Institute in University Chapel at 2 o'clock with Hon. A. P. Grout, chairman of the Animal Section, in the Chair.

After music by the Angelus Ladies' Quartette, the chair called for the report of the Committee on Breeding Cereals, which was submitted by the Chairman, Mr. L. S. Klinck, of St. Anne de Bellevue, Quebec:

REPORT OF COMMITTEE ON BREEDING CEREALS.

By L. S. KLINCK, *St. Anne de Bellevue, Quebec.*

SEARCH FOR FOUNDATION STOCKS.

We are not at all certain that the best varieties of cereals are being grown in all localities. It would be a waste of valuable energy for a breeder to devote years to breeding up a cereal which was poorly adapted for the particular climatic and soil conditions to be met. Having this in mind the breeder will first spend considerable energy in finding out what type of cereal is best adapted for his conditions. He will either himself search all the places in the world having similar climates and soils for possible varieties, or he will make use of the results of such a search conducted by others. Breeders at the present time in the United States are able to make use of the search carried on by the Division of Seed and Plant Introduction of the United States Department of Agriculture. It would be of little use for the breeder to choose new stocks from regions radically different than his own. It would be folly to bring varieties adapted to a moist climate to the sub-humid region of the Middle West of the United States or Canada. In selecting foundation stocks, then, the breeder will choose varieties which have been grown for long periods under soil and climatic conditions similar to those in which he intends to grow the crop.

METHODS OF STARTING FOUNDATION STOCKS.

Long experience has already shown the breeders of plants that certain types are better adapted for growing in certain localities than are certain other types. For instance, a different type of barley is

adapted for growing in the high mountainous regions of western United States and Canada than it is for growing in the lower moister altitudes in the eastern and central parts of the United States and Canada. The breeder in choosing types must take cognizance of these type differences and type adaptations. After the types have been decided upon either by experimenting directly, or by making use of the experience acquired by others, the breeder must decide how he will start his breeding operations with these new stocks. The climatic and soil conditions of two different countries even where they are very similar are never identical. For this reason it is often very difficult to determine in the first two or three years which of the varieties within the types are the best for the particular region. The first operation of the breeder in obtaining new foundation stocks will be to grow them in comparison for a number of years until they have past through their period of acclimation, and have become adapted somewhat to their new environment. After this period of test has passed the breeder will be able to tell which of his imported stocks are best, and he will confine his attention largely to those types and those varieties which are best adapted and give the best results to start with. Some other variety or type may have some peculiarity, for instance, extreme hardiness in winter cereals, which would make it very desirable to breed, but in general we may say that we had best confine our efforts to that variety which starts with the largest number of favorable points for its production.

THE METHOD OF BREEDING.

At this point the most intense methods of improvement must be decided upon, methods which will improve the variety in its new habitat. The methods which have been in vogue so far for the breeding of cereals have been what were known as the centgener methods. In these methods full beds, that is beds containing several thousand individual plants uniformly distributed, are planted from the foundation stock of seed. All but a few of the best plants in these foundation beds are discarded, and these are bred in the future by centgener methods, that is, each of these plants selected from the full bed is used as a mother of a centgener. One hundred seeds are planted from the seed of each of these mothers, giving an equal amount of ground to each individual, and the value of the mother plant is determined by the average production (per plant) of the centgener. Experiments have not been carried on carefully enough nor to a sufficient extent to tell whether or not the centgener method, as carried out at the present time, will give the best results in cereal breeding or not. Careful investigators should be encouraged to try a number of methods contemporaneously with the centgener method in order to decide which is the best method. In the centgener method each individual plant is given an equal amount of soil space. This condition is somewhat different from what the plant would have if growing in the field, and

we have no means of knowing as yet whether or not such a method will give the best plant.

In order to determine this very point I would suggest that some investigator take up and carry out a carefully planned experiment, in which the centgener method would be compared with the row method, the drill method, and the Burbank method. By the row method I mean planting cereals in rows which shall be some definite distance apart, and keeping the plants separated from one another by an appreciable space so that individuals may be studied. By the drill method I mean planting cereals in drills of the same width as those commonly used in seeding the fields of the particular region where the breeder is carrying on his operations. Thus in Nebraska, we commonly use grain drills having the shoes 8 inches apart. For such arrangement I would suggest planting the cereals in drills 8 inches apart, and then planting the individual plants different distances apart within the drilled row. By the Burbank method I mean planting in the foundation beds a superabundance of seed, so much in fact that only a portion of the seed can possibly develop, the best plants being carefully picked out from the thick mat which results from such a method of seeding. If we had at the present time positive data on the comparative value of these different systems we would be in much better position to proceed with our cereal breeding. We would know then that the method which we were using was the best, or if it was not the best we would know in what it was deficient. We would know its limitations. We might find upon experimentation that a combination of some two of these definite methods would be better than any one singly. Since the success of our breeding operations will often depend upon the correctness of our methods of practice I cannot too strongly urge the importance of experimentation along the lines just suggested.

SELECTION.

It is pretty generally conceded by the breeders of the present day that the basis of all selection should be the individual plant. Many experiments throwing light upon this subject have been tried, and their results mostly point to this conclusion. Still we are in considerable need of further experimentation to know whether the individual is the best basis for selection in all the various crops. It is barely possible that the individual might be the best basis for one crop, and not the best for another crop. Careful experiments should be planned and executed which would throw light upon this subject. We are not sufficiently well informed as to whether a number of individuals or a group should not constitute the basis of selection in some of our common cereals, and to decide this point experimentation is the only recourse. Careful methods of procedure not only in respect to the handling of the crop, but also in respect to methods of keeping, recording, and tabulating the notes have been worked out for the centgener method of breeding. These vary somewhat in the hands of different individuals, and in the hands of the same

individuals under different conditions. The methods pursued at the University of Minnesota have been used as a basis for nearly all the centgener breeding work carried on thus far. A number of improvements have been made at the Nebraska Station to meet the special conditions arising there which are applicable in many other places. These methods are all on record and can be obtained from the various parties using them at the different institutions, so that a detailed statement need not be made of them at this point. No matter what method of selection has been adopted for the more careful part of the work, whether it be the centgener method, individual (by individuals or groups), or row, drill, Burbank, or field methods, the time comes at last when the minute work must cease and field tests must be made. These should be sufficiently long to determine under the given conditions which is the better of the improved sorts tested. This field test should be carried on under as many as possible modifications of the climatic and soil conditions which the crop must meet if grown commercially.

DISTRIBUTION.

Before a cereal is ready to be distributed it must have passed through all of the stages of careful breeding. Having passed through these stages it will have a pedigree because a careful record will have been kept of all the ancestors. This record will give the performance of the new sort very exactly so that the purchaser will be assured of the quality of what he is buying. Having established a pedigree with performance records attached, the mode of getting the improved cereal into the hands of the individual farmers who are to grow it must be taken into consideration as one of the problems of the plant breeders. My knowledge of human nature would suggest to me that improved seed of this kind when sold should be accompanied by pedigree in all cases. I do not think that it is a wise policy to distribute improved grains or cereals in any other way. Farmers will take good care of those things which it has been hard to obtain. If they have to pay good hard-earned cash for an improved sort of grain they will take better care of it, and make a greater effort to make that grain repay them in money value than they would if the grain came into their hands without cost to them. Another factor enters into this consideration at this point, and that is that only those persons who are interested in getting improved cereals will invest their money, and thus the grain will be obtained only by those parties who are first desirous of improving the quality of the cereals which they grow, and this is a point that cannot be considered lightly. Data should be accumulated and experiments should be tried concerning the best ways of making pedigrees, the best ways of recording same, and the best ways of controlling the sale of the same under different conditions. This in itself is a subject of investigation entirely worthy of considerable effort from plant breeders if they are to accomplish all that is possible in the improvement of cereals. For instance, in

Nebraska our improved cereals are sent out first to some of our co-operative experimenters who grow the seed and sell it, being helped in the sale by the experiment station, the experiment station officers reserving the right to check up the methods employed to keep the improved strain pure and of high quality. Somewhat similar methods are in use in Minnesota, and I believe also in Ohio. A careful effort should be made by the American Breeders' Association to collect data on these various methods showing the defects in practice, and the advantages, and to publish it in some of their yearly reports for the benefit of members of the association.

PROBLEMS FOR THE CEREALIST.

Wheat.—The problems to be met by the breeder of wheat are very numerous, and are probably better in hand and have been better investigated than in case of any other cereal. This is especially true in the United States. Each of our wheat regions of the United States and of Canada has its own problems to meet. The soft-wheat regions have entirely different problems from the hard-wheat regions. Many of these problems have already been touched upon, and called to notice by other investigators, notably, Mr. M. A. Carleton of the Bureau of Plant Industry, United States Department of Agriculture, and a further consideration of the problems relative to wheat need not be given at this point.

Oats.—The problems which present themselves to the attention of the oat breeder will depend somewhat upon the purpose for which the oats are to be used, and of course will depend a great deal upon the soils and climatic conditions under which the oat crop is to be grown. For the central West and the Southwestern States, early maturity is a characteristic that the breeder must take into consideration because the mere ability to mature a crop in a comparatively short time may mean in the sub-humid or semi-arid regions the difference between a fair crop and no crop at all.

Barley.—The problems which the barley breeder must meet are many. He will be called upon to breed barley for at least two widely diverse uses—as a stock food, and for the production of beer and other malt products. The trend of the breeding operations therefore will depend upon which one of these uses the breeder has in view. Certain types of barley are better adapted for growing under mountainous conditions—that is, conditions of high altitude—and other types are better adapted for growing under conditions of low altitude. These types should be studied more thoroughly than they are at present. The value of high or low protein barleys for malting purposes is in dispute at the present time. Careful investigations should be continued as to relative value of different protein contents for this purpose. At the same time careful experiments should be conducted to determine the possibilities of breeding barleys high or low in protein, or high or low in starch. Careful breeding experiments should be conducted with the so-called naked barleys and their possibilities of

improvement, as compared with the hulled barley. Many more problems concerning barleys are yet to be decided. These should be carefully gone over by this committee and incorporated in a report to the association, and should be published in the proceedings for the guidance of breeders.

Rye.—The problems confronting the rye breeders are various. Many of these problems are fundamental and concern the methods of breeding the crop. It is not known as yet how close individual selection can be carried with this crop, nor how much cross fertilization should be encouraged or permitted. Rye should be bred both for its production of grain and the production of straw in the mature state. The demand for rye straw for use as a stuffing material in horse collars and for similar purposes calls for a satisfactory length and quality of the straw. This is of sufficient importance to merit careful breeding operations to better the product of the straw. The grain is in itself of sufficient value to merit careful breeding operations. Breeding operations should be undertaken, among other things, to establish strains immune to ergot. Rye is in use in many places as a valuable forage and soiling crop, also for green manuring. Its use for these purposes is of sufficient importance to merit more careful breeding operations to develop better adapted strains.

Durum Wheat.—The problems to be met by the breeder of durum wheat are exceedingly numerous. Among the more important of these is the careful breeding to increase yield in those sorts found to have good bread-making qualities. More scientific breeding should be undertaken to improve the bread-making quality of these better sorts. The plant breeder would find it a legitimate field for his operations to study different methods of utilizing this crop. This statement is applicable to all the cereal crops, and is not peculiar to durum wheat alone. It is simply a little more obvious in the case of durum wheat because of the newness of the crop in this country. The value of this type of wheat as a drouth resister and disease resister should be studied and improved to a greater extent, and its power of transmitting this quality to its hybrid offspring should be carefully investigated.

Emmer.—The use of emmer as a forage and food crop in the higher altitudes and the sub-humid and semi-arid regions of the United States and Canada is comparatively recent, but it seems to possess great value for such conditions of climate. More careful tests should be made of the different types of this crop, and careful breeding operations should be conducted to increase not only the yield but the food value of the product.

The foregoing is a brief preliminary outline of the problems which are to be met in the breeding of these various cereals. For future work your committee would suggest that each individual crop be assigned to some specialist or to committees of specialists who would outline as completely as possible all of the problems to be met in the breeding of that particular crop. These individuals or sub-committees ought to be able in a year to quite carefully outline the more essential

problems that are to be met at the present time. We believe that much more valuable, much more conscientious work can be obtained by such an assignment. For each member of the committee or sub-committee would then have a definite piece of work and would be much more likely to do it than in case the work is left to be done in a general way.

CROSSING AND HYBRIDIZATION.

Some such scheme as has already been suggested for handling the problems to be met in the breeding of cereals might perhaps best be applied also to the problems to be met under crossing and hybridization of cereals. The uses now known and the possible uses to be made of crosses should be carefully outlined in a future report of this committee. The limitations of crossing, that is, what may be expected and what may not be expected from the different kinds of crossing, should be carefully investigated. Methods of manipulation in making the crosses, and methods of crossing which pertain to the selection of the parent types to be crossed should be investigated much more than at present. Methods of treating these crosses and their progeny should be much more carefully studied. We should know whether it is best to let a cross run wild, so to speak, while passing through its period of variation, or whether, for practical purposes, we should have a record of the individual changes which take place in the progeny. We are not in a position at the present time to say whether one or the other is the better practice. This can only be decided by experimentation. Some of these methods of treatment would be decided in the investigations already suggested, that is, those investigations which would throw light upon the best methods of field practice in the breeding of the various cereals.

PLAN FOR FUTURE WORK OF THE COMMITTEE.

The duties of this committee for the present appear to be mainly general, that is, it should take up these subjects in a general way and thus pave the way for a more special treatment to be taken up in future. Since some of these problems have been briefly outlined here your committee suggests that it have it in its power to call into service specialists upon the various individual problems to be considered. For instance, to deal with the problems to be met in the breeding of wheat your committee suggests that a sub-committee on wheat from the larger committee be appointed, and that some men of high attainments and long experience be placed on this sub-committee. The other members of the sub-committee should be drawn, one each (as far as possible), from the different wheat regions of the United States and Canada where the particular problems in the particular regions are most important; this sub-committee to work upon the problems concerning wheat and report to the general committee, which in turn will report to the association. Your committee believes that in this way it can make much better progress and accomplish many times as much in a given length of time. In this way each individual

on the sub-committee would have a particular task for him to do, and these sub-committees would only be appointed after a careful consideration of the men who are breeding wheat in the various regions. What has been said in regard to wheat is equally applicable to all the other cereals.

The problems to be met in breeding corn, the king of cereals, are as many almost as the counties, let alone the States in which it is grown. We would suggest, therefore, as a sub-committee for this particular cereal, a chairman selected because of his attainments to be assisted by one representative from each of the States producing corn, or preferably the members of this committee should be the persons investigating corn-breeding problems at the experiment stations in the various States.

SUGGESTIONS BY PROFESSOR SHEPPERD.

In conclusion I wish to append a very suggestive letter received from Professor J. H. Shepperd, of the North Dakota Agricultural College:

It seems to me that a practical way of naming strains and registering the pedigrees of varieties of grain in such form that the individual grower can identify a particular strain is a very important and difficult feature which needs working out.

Establishing the authenticity of the pedigree of a variety of grain which has been placed in the hands of growers is a very difficult matter. I am not prepared to suggest anything in the way of improvement in this direction except the point, that I believe a name adheres to a man's mind more tenaciously than a number and that the investigator who uses a number for his own distinguishing mark should accompany it with a name.

A second question which seems to me worth raising is how best to encourage cereal production by means of State, county, and district fair premiums. It seems to me that the grower of improved grains should come nearer approximating the animal breeders in the advantage secured from showing his products at the fairs of the country. A member of the Board of Directors of a prominent State Fair Association, who is also superintendent of the agricultural department of the fair, urged me this season to outline a better method or name a way in which he could increase the number of exhibits and the interest in such displays. He already has a strong contest for prizes by counties and by farms upon collective exhibits where cereals predominate and he also has prizes upon collective corn and collective cereal exhibits shown by individuals; and still he finds the number of contestants decreasing slightly instead of increasing. I suggested larger premiums and he replied that public sentiment and interest do not support him well enough to bring such appropriations, and that the exhibitors of cereals will not sacrifice money and time (really charge it to advertising account) as the live stock exhibitors do.

I believe the chief trouble is the lack of a tenacious identity of the name and pedigree of an individual sort which reduces the advertising value of winning a prize which is the chief incentive to the live stock exhibitor.

Chairman GROUT. We will now listen to the report of the Committee on Theoretical Research in Heredity, Mr. Charles W. Ward, of Queens, N. Y., Chairman.

REPORT OF COMMITTEE ON THEORETICAL RESEARCH IN HEREDITY.

By CHARLES W. WARD, *Queens, N. Y.*

Your committee has found itself scarcely prepared to render a complete report upon the subject. The laws governing the transmission of hereditary traits are not at present sufficiently well understood to warrant the committee in recommending any theory or set of theories for experimenters in this field to follow.

There is, however, sufficient material now in existence to guide the student in heredity research well into the field and to give him certain tangible facts as starting points. The field is so broad and the ramifications of the subject are so intricate and profound that there is ample room for many groups of investigators interested in demonstrating nature's laws governing the reproduction of species to follow out special lines of research work with a probable certainty that each group of workers will secure valuable information, the compilation of which will in the end prove of immense benefit to the human family.

It will be admitted by all that any information tending to aid the human being to bring forth improved offspring will prove of inestimable value to the race as soon as it can be transmitted to the thinking public and a sufficient number of people can be impressed with the benefits to be derived therefrom to induce them to put it in practice and afford practical living demonstration of the soundness of the theories advocated.

For instance, if Redfield's doctrine that "the great mass of criminals and prostitutes are recruited from children born of parents ranging from 16 to 20 years of age at the time of the birth of the children" can be accepted as proven, we then have a positive reason for discouraging youthful marriages, or even prohibiting them by law, and could we bring the mass of people to understand and appreciate the importance of foregoing marriage until a certain safe degree of maturity has been attained, we might thereby greatly reduce the number of immature marriages and consequently reduce the percentage of births of children congenitally inclined to crime. Such a reduction would thus contribute directly to raising the average of moral excellence of the mass of the human race.

Again if the doctrine of "use inheritance" can be demonstrated, and it shall come to be known to be a fact that great scholars, great musicians, and others distinguished on account of their powerful intellects are mainly children born of mature parents, after such parents had cultivated within themselves by years of study, use, and practice the very attributes which they transmitted to their offspring we would have clearly pointed out a practical way to improve the human offspring by limiting the time of conception and birth to that period of life and to those conditions in which the parents are best fitted to

produce the desired type of offspring. Thus, this doctrine could well be invoked in the production of any type of human being, whether scholar, artisan, or laborer, and the same doctrine could also be invoked as well to prevent the production of offspring from mature confirmed criminals.

Unfortunately the evidence in favor of these theories is as yet too meagre to allow of safe deductions. It is greatly to be desired that more extensive careful research be conducted on the subject of heredity in human beings, and it is of the highest importance that such research be conducted by carefully trained conservative investigators. No more attractive field of study and speculation exists in the whole realm of human thought and activity than that of heredity in man, and as a result many writers wholly unprepared by training and experience have studied and written on this subject. Erroneous doctrines attractively presented might be very injurious, and the inexperienced reader has no way to distinguish between the good and the bad. The Committee on Heredity consider that it is one of their functions to become familiar with the literature bearing on the subject of human heredity, and wherever books and papers appear which treat the subject in a conservative and safe way, recommend them to the consideration of the reading public. Such recommendations, however, cannot be made in the present report.

The principles of heredity can doubtless be worked out more readily by investigation with animals and plants than with man, and as the same principles apparently hold good in general throughout the organic world, it would seem that at the present time what is most needed is carefully planned experiments with plants and animals where large numbers can be used and where the parentage can be controlled. Indeed, it is in the breeding of plants and animals that any new principle discovered will be applied promptly and have its greatest immediate value. It would require years for the knowledge of such a principle to become sufficiently general to materially influence the human species, even if it is capable of being adopted in this capacity.

Mendel's laws or principles of heredity which have attracted such widespread attention require to be studied more thoroughly and critically. The limitations of Mendelian characters are yet very imperfectly understood, and there is need in this field for research on many widely different plants and animals of both wild and domestic varieties and species.

The mutation theory of Dr. Vries has also opened to the student of heredity and breeding a new and fertile field of experimental research. The study of mutations and other types of variations and their hereditary strength and importance in the formation of varieties and species is of the utmost importance. It seems probable from recent researches that mechanical means may be used to force such variations, and if such methods can be devised they would be of great aid to the practical breeders of plants and animals. Throughout the recent literature on heredity, Mendel's law and the mutation theory, the conception of

unit characters represented probably by some tangible protoplasmic unit which is transmissible from cell to cell and in sexual unions has become a dominant idea. It is very important that careful cytological studies be made of hybrids and their parents and of mutations, to determine so far as possible the protoplasmic mechanism of heredity. It will be the aim of the Committee on Heredity to encourage work on the various important problems and from time to time present papers summarizing the knowledge on the various important factors.

Appended to the present report are short statements regarding some of the important problems by Dr. C. B. Davenport and Professor W. J. Spillman, which are submitted for publication following this report.

Respectfully submitted,

C. W. WARD, *Chairman of Committee.*

RECENT ADVANCES IN THE THEORY OF BREEDING.

By DR. CHARLES B. DAVENPORT, *Cold Spring Harbor, New York.*

The new era in theoretical breeding opened in 1900 with the rediscovery of Mendel's law. At the same time something even more important was disclosed; namely, that Devries, Porrens, Tschermak, Spillman and still others were already advanced in extensive, accurate, and even statistical studies of inheritance in plants and animals. The rediscovery of Mendel's law was no accident; it was the necessary consequence of the new studies, and similarly these new investigations were the natural growth of a time fully ripe for them.

The apparent difficulties of pedigree breeding had deterred many scholars who realized its importance from attempting it, but after the task was actually undertaken its difficulties were seen to have been overestimated. At the present time even in universities, where there is no school of agriculture, excellent work in breeding is being done, for instance by Devries at Amsterdam; by Bateson and his pupils at the University of Cambridge, England; by Correns at the University of Leipsic; by Cuenot at the University of Nancy; and in America by Castle at Harvard, by Morgan and Crampton at Columbia, by Whitman and Tower at Chicago, by Moenkhaus at Indiana, and by Kellogg and Miss MacCracken at Stanford. Pedigree breeding at the non-agricultural universities has developed greatly in the last five years, a fact that promises well for the future.

The agricultural schools are at last awakening to their opportunity to contribute to research on the laws of heredity. Abroad such work is being done by Tschermak at the Agricultural College of Vienna, by Plate at Berlin, by Toyama at Tokyo; and in this country by Gowell at Maine, Rice at Cornell, and Erf at Kansas, all working with poultry, and by scores of others working with various groups of animals and plants. Nor must we overlook the numerous independent scientific breeders, like Alexander Graham Bell on his Nova Scotia sheep farm.

At the same time societies of broad scope have been established. Thus, in addition to the American Breeders' Association and the International Congress of Plant Hybridization, there has recently been established the Deutches Gesellschaft für Züchtungs kunde. Thus the number of workers and their organizations are fairly satisfactory. The scientific results of experimental investigations in breeding are now multiplying rapidly. Mendel's law is coming everywhere to be recognized as the starting point for studies upon inheritance. The newer investigations are, however, revealing certain important accessory and modifying laws which deserve a more detailed consideration.

First.—Mendel's law of dominance is not universal; it holds primarily for non-blending of alternative characters. Numerous allomorphic characteristics form a mosaic or even blend in the offspring. Thus, Castle has shown that the length of the ear in the young of short-eared crossed with lop-eared rabbits is intermediate between the parents and of the intergrading there may be all degrees. Similarly in poultry the height of the nostril and the degree of booting on the feet thus blend.

Second.—Reversion is a phenomenon that has long been noticed and which was studied by Darwin. He spoke of reversion as though it was in opposition to the usual laws of inheritance, which in hybridization are transcended as it were by a new law of return to an ancestral condition. It is, however, now becoming clear that reversion is no infraction of the ordinary laws of inheritance but constitutes a special case of inheritance in hybridization. In the color of animals it usually results from the crossing of a black with a light, revealing red or a hidden pattern. Either the pattern is hidden in the black by an excess of melanic pigment, or else it is latent in the white parent, requiring some pigment to bring it into view. For example, when a black spanish cock is crossed with an albino-plumaged silky, the offspring are black and red, the red not being visible in either parent. Yet, the areas occupied by the red can be distinguished in the black plumage by peculiar properties of the black in these areas. The result is as though the deficiency of a pigment in the albinic silky canceled the excess of black in the Spanish plumage, revealing the hidden red. Many other cases of reversion may be similarly explained.

Third.—The Mendelian law takes no account of the immediate characters of the parents, but only of their ancestry. Hybrids *a* and *b* may be very unlike in given characteristics, but if they have the same ancestry, they should (according to the Mendelian formula), when mated with a hybrid male of the same origin as themselves, each produce offspring in which the various grandparental characteristics recur in the same proportions. My own studies, still unpublished, do not confirm this dogma. On the contrary, from the somatic condition of the hybrid mother, much may be predicted as to the parentage distribution of the characters in the offspring. For example, when a single-combed bird is crossed with a V-combed bird, the hybrids all have

Y-combs, but the proportional length of the arms of the Y to the stem varies from 5 to 95 per cent. If two females, one with a 5 per cent split and the other with a 95 per cent split be mated to a single-comb male, Mendelian expectation is 50 per cent split comb and 50 per cent single in the offspring of either female. But actually the female with the slightly split comb will throw an excess of single-combed while the female with a deeply split comb will throw a deficiency of single-combed offspring. The average of the progeny of *a* and *b* together may well be 50 per cent single, but the percentage in the offspring of *each* form of comb will differ greatly in the two cases and the percentage can be approximately inferred from the somatic condition of the immediate parents.

Indeed it has become daily more apparent that from an observation of the soma much can be inferred as to the contents of the germ glands. As is well known in hybridization experiments, all of the offspring of the first hybrid generation usually inherit only one (the dominant) form of two allomorphs. In the second hybrid generation, we get 25 per cent with the recessive form, which henceforth breeds true and 75 per cent with the dominant. Of this 75 per cent, one-third are pure dominants and when bred inter se breed true and two-thirds are heterozygous, forming gametes of both kinds. It is usually stated that the pure dominants cannot be distinguished from the heterozygous dominants except by breeding tests, but this is usually not true, for one who is well acquainted with his material will usually observe differences in the appearance of the two kinds such that he can quickly select the pure dominants. Thus when a white leghorn is crossed with a Black Minorca the offspring are all white with scattered black feathers. If these offspring be mated together 25 per cent black offspring appear and 75 per cent white. But of the 75 per cent white, one-third will be pure white and the rest will have black specks. The pure white will usually be found to be homozygous. Thus the heterozygous form has the hybrid nature of its germ cells stamped upon its soma.

Now that we recognize that many of the characters of plants and animals are of the order of mutations, it remains to investigate methods of inducing mutations as fluctuations have long been induced. Our colleague, Dr. MacDougal, has succeeded in this line of work by injecting into the ovaries of plants certain salts. In how far this or other methods of inducing mutations may be extended remains to be seen, but it is clear that the experiment deserves to be tried immediately on other materials.

More and more it becomes clear that problems of inheritance are chemical problems, and that the development of this or that characteristic of the adult is due to the presence of a specific enzyme in the germ cells. Thus an albino mouse may be derived from a gray mouse, a black mouse, or a chocolate mouse. Now albinos of whatever origin when bred inter se produce always albinos. But if an albino that has been extracted from a gray be bred to a colored mouse (e. g. chocolate),

the gray will appear in all the offspring, or if the albino were one extracted from a black, the offspring will all be black. The albinos look alike only because they lack one or two color-producing factors. When the lacking factor is supplied by a pigmental animal of any sort, the particular ancestral color appears again. Similarly in poultry the germ cells of an albino plumage, such as the silky has, behave very differently in inheritance from the dominant white as seen in the white leghorn, and this difference in behavior of the two whites corresponds to a difference in their chemical composition. Indeed the fact, that the enzymes of the germ cells and particularly of the egg determine hereditary characters, points the way to the modification of hereditary qualities, and to the production of this or that character at will. Such, at least, is the goal of the investigator.

THE CHROMOSOME IN THE TRANSMISSION OF HEREDITARY CHARACTERS.

By Professor W. J. Spillman, *Washington, D. C.*

I cannot help thinking that the committee on theoretical research in heredity is one of the most fundamentally important of all those that have been appointed. There is a disposition in some quarters to look upon theoretical research as something impractical and of little value. The fact is, however, that, when our theories have once been brought into accord with fact, they become of the utmost practical importance. If our committee can work out the actual facts concerning the manner in which hereditary characters are transmitted from one generation to the next, it will have rendered a great service to the men who are attempting to produce improved strains of plants and animals.

It seems to me that we ought to call attention in our report to those points requiring further investigation before a complete theory of heredity can be established. For instance, Wilson and a few other investigators have found an extra chromosome in the nuclei of certain animals. This chromosome does not take part in synapsis and therefore does not divide in the first post-synaptic division, but passes into one of the resulting cells. The two cells thus produced therefore have a different organism. They then split into four, two of which have each the extra chromosome. This chromosome is present only in the germ cells produced by the male. It is believed that when the ovum is fertilized by a male cell not having the extra chromosome the resulting chromosome is female; but if fertilized by the germ cell having the extra chromosome the progeny is male. It is easy to see the importance of this point to the practical breeder of animals. If it can be demonstrated that sex is controlled by the presence or absence of a particular chromosome, it settles for all time the question of sex con-

trol. We ought to get together what information is now available regarding the relation of this accessory chromosome to sex, and urge cytologists to investigate the subject further.

Here is another very important point in its relation to a satisfactory theory of heredity. Cytologists, a good many of them at least, are coming to look upon the chromosomes as the bearers of hereditary characters. There is no school of cytologists, however, who insist upon an interpretation of the things seen during the growth and division of the germ cells. This introduces great confusion and renders any satisfactory explanation of known results in breeding practically impossible. We ought to point out the relation existing between the synaptic process and the transmission of hereditary characters, and insist that cytologists shall come to an agreement about the facts. If it is once understood that the chromosomes are the bearers of hereditary characters, we may then hope to get cytologists to work on the relation between the different chromosomes in the same nucleus and the different hereditary characters of the organism. I believe that it will finally be possible to work out the complete relation so that we can get a full understanding of the behavior of hereditary characters and thus breed for improved forms with almost as much certainty as the chemist mixes solutions in order to produce a desired compound.

Another subject of very great importance is that of the relation of characters. In Volume II of the American Breeders' Association, you will find a paper by Webber on this subject, in which he shows that certain apparently non-related characters are nearly always transmitted together in breeding corn. He thinks, however, that in a few individuals these characters become separated. If such is the case, it has a very important bearing upon the theory that the chromosomes are the biological units which carry hereditary characters. Bateson of England has given much study to correlation of this kind, and he does not find the splitting apart of correlating characters reported by Webber. He does find, however, that sometimes one or two correlated characters meet a dominant in a cross and thus disappear temporarily. I have already urged Webber to continue his work with corn to ascertain whether the vanished characters are really separated from their partners or are simply covered up by a dominant.

Some hybrids have been reported which do not follow the usual Mendelian laws. There are two classes of them. The first class resembles one or the other parent and its progeny does the same. They, therefore, fail to break up in the second generation as hybrids usually do. The other class is intermediate between the parents but breed true to type from the beginning. Careful cell studies ought to be made upon these hybrids to ascertain whether the chromosome behavior is normal in them. Such study ought to throw light upon the relations of the chromosomes in hereditary characters.

If the chromosomes bear the unit characters, these chromosomes must, in the first post-synaptic division, be perfectly true to assume alternative positions whereby the paternal half of a bivalent chromo-

some is just as apt to go to one daughter cell as the other, while the maternal half of the same chromosome must go in a direction opposite to that of the paternal. In some hybrids it is possible to distinguish between the paternal and maternal chromosomes. These hybrids ought to render it possible to determine whether the chromosomes actually might assume different positions in the metaphase of the reduction division. The examination of a large number of cells in such a hybrid would demonstrate whether the position of the chromosome is governed by the law of probability. If such should prove to be the case we have at once established a mechanism in the actual behavior of the chromosomes that will account for Mendel's law. Hybrids such as that produced by Rosenberg between Droseri rotundiflora with 10 chromosomes in the gametes and Droseri longiflora with 20 smaller chromosomes lend themselves to such study admirably, and should be further investigated.

I have outlined above a few of what seem to me to be the more important problems in theoretical research relating to heredity at the present time. I realize, of course, that every man has his own views, and it may be that other members of the committee will take an entirely different view of our work.

As I said before, this subject of heredity is a vast subject, and the members of the committee I think all recognize that we have a task before us which, up to the present time, we really do not know a great deal about; but if our lives are spared long enough and we persist in the inquiries which we have in view, we hope to accomplish something.

Chairman GROUT. We are next to hear the report of Secretary Hays, who will in connection therewith present certain resolutions which have been considered by the Council and adopted by them for recommendation to this body at the meeting of to-day.

Secretary HAYS. The Council has recommended for passage the two resolutions which follow:

(1) Resolved that the American Breeders' Association urges upon the Congress of the United States and the legislatures of the respective States that they continue their liberal policy of building up educational research in agriculture, including that relating to the production and improvement of plants and animals.

(2) Resolved that the Committee on Eugenics be authorized to organize either as a committee of the American Breeders' Association, or as a separate society. The American Breeders' Association, however, desires to express the opinion that since the principles of heredity seem to be common to all plants and animals, including man, and since the data derived from the study of one kind of organism will be of importance in the study of other organisms; and since the greatest advance is to be expected from the widest co-operation, it would seem appropriate and desirable that the Committee on Eugenics should work in connection with the Animal Breeders' Association.

Mr. Chairman, I want to say just a word regarding those two resolutions. The first is in favor of the expenditure of money for country-life education; and it is presented in this Association because it gives us a chance to say a word about education along the lines of improving plants and animals both as an education and as a research.

The other resolution is put in its present form because some of the people whom this Association has asked to take up the matter of heredity in the human family think that the organization might better be a separate and independent one.

I will not go into a discussion of their reasons, particularly, further than to say that some of those people thought after a great deal of discussion that, if that work were broadened out so as to touch the wide human interests, we might proceed along lines somewhat divergent as compared with the publications of this Association; and, since some of those gentlemen feel that way, and since we have placed the matter in their hands to suggest the form of organization, it was thought wise to give them freedom of action. I might say that, as many of you know, the announcement that such a committee was to be organized created a widespread interest. The gentlemen named on the committee are interested in the subject, but the committee has not yet organized for work.

I might say regarding a number of the committees, that their organization is not yet complete. They have been in a formative stage during the past year; in many cases, no plans regarding the lines of work that are to be taken up, and no plans for organizing the work have been made; and in some cases, even the matter of appointing men permanently upon the committees is yet to receive attention. This has been left by the Council pretty largely in the hands of the men assigned to work on these committees.

I have the honor, Mr. President, to move that the first resolution regarding agricultural education be adopted by the American Breeders' Association.

The motion was seconded by Dr. Chamberlain, put by the chair, and declared carried.

Secretary HAYS. Mr. Chairman, I have the honor to move in the name of the Council the adoption by this meeting of the resolution regarding the Committee on Eugenics.

This motion was seconded by Dr. Davenport, put by the chair, and declared adopted.

Secretary Hays then submitted the following financial report, which under the rules was referred to the Auditing Committee:

FINANCIAL STATEMENT.

The following is the financial statement prepared and submitted by Secretary Hays:

Financial Statement of the American Breeders' Association for the Year January 10, 1906, to January 12, 1907.

	Receipts.	Disbursements.
Annual dues, pledges, and reports sold	$1356.54	
Life dues	300.00	
Life dues transmitted to Treasurer		$300.00
Expenses:		
Postage		313.28
Printing		736.26
Miscellaneous items		68.11
Balance of contingent fund in bank		177.39
Contingent fund in hands of Secretary		61.50
	$1656.54	$1656.54

Resources of the Association, January 12, 1907.

	Contingent Fund.	Life Fund.
In hands of the Secretary	$238.89	
In hands of the Treasurer	46.78	$960.00
Total	$285.67	$960.00

The following bills are still outstanding:

For printing:	
Williams & Wilkins, Baltimore, Md	$438.23
Byron S. Adams, Washington, D. C	40.15
C. E. Davis, Washington, D. C	51.35
Total	$529.73
For postage	11.62
Grand total	$541.35

Secretary HAYS. I made verbally most of the statements that I care to make in the report. The Assistant Secretary has prepared a brief statement that will be filed covering practically what I said

yesterday. He says that the annual membership is now 1000, and in addition there are 47 life members.

It has been demonstrated that the work of increasing our membership must be centered largely in the Secretary's office, where systematic accounts can best be kept.

The Secretary desires to ask the members to furnish his office the names of breeders whom it will be worth while to invite to become members of this Association. If you will write to your friends and tell them that you have recommended them, and then write to us and give us their names, we will send to each a letter and follow this up, if necessary, with two or three more letters. It takes a great deal of work, for which nobody is getting any pay from this Association. We need more money to put this Association on its feet, and I may say, gentlemen, that it is largely up to the people who are interested.

Chairman GROUT. The financial statement will be referred to the Auditing Committee. I believe that is the order.

Mr. DODSON (of Louisiana). I would like to offer a resolution in regard to the free distribution of seeds by Congressmen, asking that the funds utilized for that purpose at present be in future given to the Department of Agriculture and the Experiment Stations for plant breeding and the introduction of new strains or varieties of plants and seeds.

Secretary HAYS. Mr. Chairman, may I ask that Professor Dodson put his resolution in writing and send it to the Council for consideration at our meeting this afternoon? It is the rule that these resolutions go to the Council. That is the committee on resolutions. If there are other resolutions, Mr. Chairman, they should also come to the Council.

I should say, gentlemen, that I expect to go away this evening on account of work that has suddenly come up in the Department of Agriculture at Washington. I am very sorry to do this. I will ask that the young gentlemen who have these envelopes will distribute them, and they will be collected later and receipts will be given to those who subscribe. I hope you will all join the American Breeders' Association.

Chairman GROUT. The next order of business is an address on "Breeding Tobacco," by Professor A. D. Selby, botanist of the Experiment Station at Wooster, O.

TOBACCO BREEDING IN OHIO.

By A. D. SELBY, *Ohio Agricultural Experiment Station, Wooster, O.*

BEGINNING OF THE WORK.

Beginning in 1903 at the request of tobacco growers of the filler district of the State, the writer has been engaged in efforts to improve present sorts of cigar-filler tobacco. During 1905 and 1906 the efforts have been extended to the Medina-Wayne county wrapper area.

The initial tobacco investigations of the Ohio Experiment Station were begun upon the establishment of a southwestern test farm at Germantown, O., to study tobacco and other problems; this was secured very largely through the efforts of the Germantown Tobacco Growers' Association, and in the outset the studies in breeding were naturally devoted to the cigar-filler tobaccos of that region. Preliminary publication of these beginnings was made in a bulletin of the Ohio Station in November, 1904.[1]

In all tobacco breeding investigations with which the writer has been concerned he has enjoyed the efficient assistance of Mr. True Houser, Assistant in Plant Breeding, to whom he would at this time express his obligations.

TOBACCO DISTRICTS OF OHIO.

It may be proper here to point out the diverse character of Ohio tobacco growing. While three-fourths of the total tobacco production of the State is probably of the sort known as "cigar-filler" tobacco, there are three other distinctive tobacco districts in Ohio. Taking them in order of production the tobacco districts of the State are as follows:

First. The cigar-filler district including a number of counties in southwestern Ohio, among which Montgomery county is the highest in tobacco production and is in the center of the area.

Second. The plug-tobacco district, also in southwestern Ohio, consisting chiefly of the counties of Hamilton, Clermont, Brown, Adams and Scioto.

Third. A smoking or export-tobacco district fringing the Ohio river in a number of eastern or southeastern counties, more or less intermingled with local areas devoted to growing plug grades.

Fourth. A small cigar-wrapper district in the northeastern part of the State, including portions of Medina and Wayne counties, and producing wrapper tobacco of a grade approximating that of Connecticut. The accompanying map will indicate the location and extent of these areas.

[1] Bulletin Ohio Agric. Exp. Station 131, 1904. II. Tobacco Breeding, pp. 108-114, with 3 plates.

VARIETIES GROWN IN OHIO.

The varieties of tobaccos grown in these several districts are characteristic and distinct. In the large filler district the typical variety is Zimmer Spanish, which probably originated after the manner of the Connecticut Havana variety, by selection from Cuban tobacco grown

OHIO TOBACCO DISTRICTS.

for some time at the North. Along with this, considerable quantities of Connecticut Seedleaf, Ohio Seedleaf, and other seedleaf types under local names are likewise grown. In the plug-tobacco district the variety most largely grown is White Burley. In this respect it is of like character with the central Kentucky district, which it adjoins. Lately there has been some growing of filler types like "Zimmer" in

this area. In the southeastern districts, excepting local areas where White Burley is grown, the varieties are similar to the Maryland and Virginia smoking tobaccos. In the Medina-Wayne area the wrapper varieties are grown exclusively. Connecticut Havana is the favorite, followed by Connecticut Broadleaf.

OHIO BREEDING PROBLEMS.

As was stated on the part of the tobacco growers of the cigar filler district, their desire seems to be to secure varieties equal or superior to Zimmer Spanish in quality, which shall at the same time be of superior productive capacity as compared with that variety. Whether this desire expresses a real need in the tobacco industry is sometimes questioned by other growers and by packers. The Zimmer Spanish, it is claimed, is a fairly productive and excellent cigar-filler tobacco, well adapted to the area in which it is grown, and well known throughout the cigar trade; it is also pointed out that with good husbandry the Zimmer Spanish is capable of producing a fair average crop of 1200 to 1500 pounds per acre, and that the much smaller average crop of the district, namely, about 800 to 900 pounds per acre is due, not to any fault of the tobacco in question, but to a lack of good husbandry on the part of the growers.

In the study of breeding problems, while we may not forget this subject of existing varieties we may defer their consideration. The tobacco growers were not only certain that better cigar-filler tobaccos could be produced, but that one way of producing such new varieties would be by crossing the Connecticut Seedleaf with the Cuban. The initial efforts of the writer and his assistant were therefore directed toward this production of hybrids of the sorts named.

HYBRIDS OF CONNECTICUT SEEDLEAF AND CUBAN.

In 1903 about 35 hybrids of these varieties were produced by crossing plants of Connecticut Seedleaf and Cuban Seedleaf. The seed for these plants had been procured from the regular channels of the trade and appears to have been fairly true to these types. In some instances —notably in numbers 51 to 64, the Cuban was the pistil parent, while in numbers 65 to 76 the Connecticut Seedleaf was the pistil parent. In succeeding seasons a large number of additional hybrids have been made by crossing a very much wider range of varieties, including crosses upon the hybrids of 1903 and hybrids of other separate varieties, which will be considered later.

The hybrids first mentioned exhibited merged characteristics in 1904, while the following year the progeny of merged selected plants broke up very decidedly, exhibiting a wide range of characters. This breaking up in the second year, however, is not to be regarded as a determined factor as in every case the seed from several plants was mixed in sowing. In other crosses of the second generation in 1906, the progeny of particular plants was constant, while the offspring of other parent plants broke up in the manner before described. In our

critical sowings since 1904 we have propagated by using the seed from individual plants alone, and shall continue this practice.

In selecting seed plants from hybrids Nos. 51 to 75 in 1905, second generation, the seed plants were numbered from 100 to 199, etc. In

Yields in Tobacco-Breeding Experiments at Germantown, Ohio, in 1906.

[Plats of one-twentieth acre.]

Plat No.	Fraction of Plat.	Variety or Hybrid.	Yield per acre.	Plat No.	Fraction of Plat.	Variety or Hybrid.	Yield per acre.
			Pounds.				*Pounds.*
1	1/2 N.	55—111	1430	18	1/2 N.	74—106	1310
	1/2 S.	55—101	1360		1/2 S.	74—103, 109	1150
2	1/2 N.	Zim. Check.	1400	19	1/2 N.	Zim. Check.	1310
	1/2 S.	Zim. Check.	1210		1/2 S.	Zim. Check.	1380
3	1/2 N.	55—110	1270	20	1/2 N.	74—Lump.	1160
	1/2 S.	55—103	1360		1/2 S.	54—106, 107, 110	1290
4	1/2 N.	55—104	1470	21	1/2 N.	54—105, 111, 118	1190
	1/2 S.	55—Lump.	1530		3/10 S.E.	Cuban—154	500
					2/10 S.W.	Cuban—102	875
5	3/10 N.E.	55—118	1766	22	1/2 N.	54—125	1660
	2/10 N.W.	55—121	1275		1/2 S.	54—Lump.	1290
	1/2 S.	72—118	1530				
6	1/2 N.	Zim. Check.	1310 } 1455	23	Full.	Zim. not suckered.	1030
	1/2 S.	Zim. Check.	1610 }	24	Full.	Zim. suckered.	1410
7	Full.	75—154	1715	25	1/2 N.	Zim. 15-yr.-old seed	1380
8	Full.	Ct. Seedleaf.	1640		1/10 S.E.	Zim. 32—109	1900
9	Full.	Zim. Check.	1455		2/10 S.W.	Zim. 31—Lump.	1825
					2/10 S.W.	Zim. 31—111, 112, 115	1600
10	Full.	75—155	1445	26	2/10 N.E.	61—Lump.	1200
					3/10 N.W.	61—124, 125	1267
11	3/10 S.E.	75—119	1483		2/10 S.E.	61—101, 103, 104, 107	1375
	2/10 N.W.	75—153	1588		1/10 S.W.	59—Lump.	1250
	1/2 S.	75—131	1170		2/10 S.W.	64—Lump.	1475
12	3/10 N.E.	Zim. 32—138	1483	27	1/2 N.	Zim. Check.	1280
	2/10 N.W.	Zim. 32—122	1500		1/2 S.	Zim. Check.	1280
	3/10 S.E.	Zim. 32—Lump.	1233				
	2/10 S.W.	Zim. 32—142	1450	28	1/2 N.	59—103	652
					2/10 S.E.	59—Lump.	1250
13	1/2 N.	75—118	1420		3/10 S.W.	59—103, 108, 109	1333
	1/2 S.	69—Lump.	1510				
				29	1/2 N.	69—110, 115, 116	1290
14	1/2 N.	75—Lump.	1430		1/2 S.	69—108, 109, 111	1410
	1/2 S.	75—117	1350				
				30	1/2 N.	59—102, 113, 115	1410
15	1/2 N.	Zim. Check.	1550		1/2 S.	59—Lump.	1230
	1/2 S.	Zim. Check.	1450				
				31	1/2 N.	Zim. Check.	1430
16	3/10 N.E.	72—119	1333		1/2 S.	Zim. Check.	1530
	2/10 N.W.	72—131	1625				
	3/10 S.E.	72—110	1533	32	1/2 N.	57—106, 118, 119	1530
	2/10 S.W.	72—Lump.	1425		1/2 S.	57—Lump.	1180
17	1/2 N.	72—108	1140				
	1/2 S.	72—113	1470				

1904 the seed plants were given numbers from 1 to 99; the same practice has been followed in all the other numbers used upon hybrid tobaccos as a matter of record. The seed plants of the first generation were numbered from 1 to 99; of the second generation from 100 to 199; in the third generation from 200 to 299, etc. Out of the medley of forms

arising in the second-generation plants of 1905, a large number were selected and so far as possible these selections of the various numbers were separately planted for the crop of 1906. Of the hybrid No. 75 several seed plants, as No. 119, No. 154, No. 155, etc. were grown from separate seedings. The same applies to the other numbers, especially Nos. 55, 56, and 72.

PRODUCT OBTAINED FROM CONNECTICUT SEEDLEAF AND CUBAN CROSSES OF 1903.

The vigor of average growth of the first generation was very marked, although the areas were too small to give comparative yields. The tobaccos produced were sweated out, subsequently tested and pronounced by smokers as inclined to be too strong. I may say to you that I do not know the meaning of this judgment, and since I learn the same judgment has recently been passed upon tobacco grown from Cuban seed in the Miami valley, you may perhaps be in like doubt.

In 1905, twentieth acre plats of these various hybrids recorded by numbers, were grown in comparison with Zimmer Spanish, the standard filler tobacco of the region. The yields in nearly every case of second generation hybrids was inferior to that of the standard Zimmer. The same was true of selections of individual seed plants of Zimmer grown in comparison with the standard seed, although the differences in these cases were quite slight.

In 1906, when extensive comparison of hybrids Nos. 51 to 75 were made in the variety test using Zimmer Spanish as a standard, Connecticut Seedleaf was also grown in this test, as was Cuban. The results are shown in the table on preceding page.

It will be seen from the table that where Zimmer, Connecticut Seedleaf, and the Seedleaf-Cuban hybrid No. 75-154 were contrasted, Plats 6-7-8, the yields were 1455 pounds for Zimmer, 1640 pounds for Seedleaf, and 1715 pounds per acre for the new hybrid, an excess of 260 pounds per acre over the local variety Zimmer, and 75 pounds per acre above the seedleaf. In this we have this selection of the hybrid yielding in excess of both parent sorts.

The quality of the unfermented tobacco, as stripped, is very encouraging; samples are being fermented of which early laboratory tests are to be made in the Laboratory of Plant Breeding, Bureau of Plant Industry, U. S. Dept. Agriculture, through the kindly co-operation of those in charge of the tobacco investigations of that Department.

Upon these tests will depend the future efforts with this hybrid as with the others. Since the photographs are fairly clear a little further discussion of the hybrid 75-154 may be in order. It may well serve to fix our attention upon one of the many. In vegetative vigor, the hybrid leaves little to be desired. It is somewhat taller (36.1 inches) than Zimmer Spanish, (28.9 inches) or Seedleaf (29.75 inches for seed plants), with 2 to 3 more leaves to the stalk; the internodes are about the same as upon the Zimmer and Seedleaf. In habit of leaf growth, the hybrid has at first semi-erect and finally almost horizontal

leaves, in contrast to the erect leaves of the Zimmer and the drooping ones of Seedleaf. The leaves are as stated more numerous than on either Seedleaf or Zimmer, ranging from 17 to 22 leaves per stalk on the hybrid against 15 to 19 for Seedleaf or Zimmer. In shape the leaves are relatively shorter and broader than either.

The measurements of leaves upon seed plants show a length of about 15 to 20 inches (extreme lengths reach 25 inches) by 10 to 14 inches in width. The leaves of Zimmer are relatively longer and narrower than these; those of seedleaf are very much longer as is known. We have used a rapid, graphic method of judging seed plants by measuring the largest leaf and the top leaf, and noting the number of leaves; a maximum leaf area of 21.5 to 24.5 square feet in this No. **75**-154 has been found as against 15 to 15.5 square feet for Seedleaf and 15 to 16 square feet per plant for Zimmer. Other promising hybrids are the other selections of No. **75** and those of No. **72**, No. **54**, and No. **55**. Hybrid **54**-125 is especially to be named among those which have excited marked interest. The half of plat 22, in 1906 gave a yield of 1660 pounds per acre, compared with 1450 pounds for Zimmer, an excess in yield of more than 200 pounds per acre. This is a tall sort with a large number of leaves approaching those of Zimmer in size and shape. The habit of growth is semi-erect and the plants do not tend to produce suckers, a consummation devoutly to be desired. Unfortunately the yields in the table are incomplete at this date as not all the sorts have been stripped. It is hoped to complete the data for yields at an early date for publication in complete form.

MISCELLANEOUS HYBRIDS OF 1904 AND 1905.

In 1904 a large number of other crosses were made both of recognized varieties upon the hybrids already mentioned and between the various varieties; later some intercrosses were made of certain hybrids. Additional crosses were made in 1905 and again in 1906 but these call for no further mention here.

Photographs of hybrid No. 81 are shown; this is a cross of No. 58 by Ohio (Washington) Seedleaf, and No. 109 of Zimmer by Ohio Seedleaf. No. 111 of which I fear there is no photograph is an intercross between Nos. 54 and 75-154. One point of interest was developed in 1906, the second generation of these hybrids, namely, that the progeny of certain selected plants, did not break up in the second year, but were comparatively uniform. No. **81**-2 and **83**-8 are conspicuous examples. Other seed plants however, did "break up" in a striking way, showing great diversity in the second generation. I will not tire you with further details of our efforts on filler sorts.

WORK IN THE WRAPPER DISTRICT.

In the Medina-Wayne area, where wrapper tobacco is grown, the efforts of 1905 were tentative. Zimmer Spanish alongside Connecticut Havana showed the same habit of growth as the latter, indeed could not be distinguished from it except upon close inspection. The

leaf produced at the North, however, was very different in texture from that grown in the filler area where it is at home. In 1906, through the kind co-operation of A. D. Shamel, his Cooley and Brewer hybrids were there grown; Wisconsin-grown seed of Connecticut Havana was also obtained through the kindness of Prof. E. P. Sandsten of the Wisconsin Experiment Station, while the writer purchased seed of Sumatra grown in this country one year.

The comparative yields of these are about as follows:

Yields of Tobacco at Seville, Ohio, 1906.

Variety.	No. of Plats.	Yield per acre. *Pounds.*
Connecticut, Havana	2	1960 and 2000
Cooley	2	2000 and 2040
Sumatra	1	1880

Cooley Hybrid and Brewer Hybrid may either or both prove adapted to the region. The high quality of the tobacco grown in the wrapper area named marks this as a very promising field for effort.

The work in most lines on tobacco will hereafter be carried forward in co-operation with the Bureau of Plant Industry of the Department of Agriculture and better facilities thus accrue for testing out the sorts of highest promise.

Music by the Angelus Ladies' Quartette followed.

Chairman GROUT. I desire to state that Colonel C. J. Jones, who is on the program for a lecture or entertainment at the Board of Trade Building to-night, is here, so that there will be no postponement or mistake about that.

The next order of business is the report of the Committee on Breeding Tobacco, which will be submitted by Mr. W. H. Sherffius, of the Kentucky Experiment Station.

BREEDING OF KENTUCKY TOBACCOS.

By W. H. SCHERFFIUS, *Agricultural Experiment Station, Lexington, Ky.*

In this article it is deemed expedient to call attention to the position Kentucky holds in the tobacco industry, the varieties of tobacco she produces, the markets she supplies, the progress made in the improvement of the tobacco plant, and the possibilities of future improvement by having the co-operation of the National Department of Agriculture.

THE TOBACCO INDUSTRY OF KENTUCKY.

Kentucky has an enviable heritage which is predominant in the various lines of her economic development, not the least of which is her tobacco industry. Western Kentucky and a considerable district in western Tennessee, centering around Clarksville, comprising the area known as the Dark-Tobacco district, produces an article which not only supplies a ready market at home, but also finds its way into the French, German, Italian, and many other European markets. Central Kentucky, comprising principally the area known as the White Burley district, is world-renowned for the quality and quantity of this particular variety of tobacco which it produces.

The natural advantages which these districts possess and the variety of uses to which their product is appropriated, illustrates the importance of developing this industry in the State to the highest degree of perfection. It should be of some interest to the tobacco breeders to know into what product most of the Kentucky tobaccos are manufactured. The largest consumption, of both the White Burley and of the Dark types, is in the manufacture of plug tobacco, it being used both as wrapper and filler, depending to some extent on the color, texture and size of the leaf. There is considerable variation in the quality of the tobacco used for plug alone. We find it grading from light yellow to mahogany and brown in the Burley tobaccos; and from a piebald to a dark red and dark brown, including the heavy Green River Filler in the Dark-Tobacco district.

Large quantities of Kentucky tobacco are used in the manufacture of smoking tobaccos, cigars, and snuff. The yellow curled Burley is used largely in the manufacture of cigarettes, plug wrappers and smoking tobaccos. The red and brown types from both the Burley and Dark-Tobacco district are used largely for plug wrapper and filler. The United States consumes a considerable quantity in the manufacture of plug tobacco, smoking tobacco, cheap cigars and snuff. Great Britain imports large quantities which are used in the manufacture of Bird's-eye Cutter, Shag, Heavy Cutter, Navy Plug, etc. France imports both the heavy and light types of dark brown tobacco, principally for plug tobacco. Italy imports the dark brown heavy types of western Kentucky and Clarksville, Tenn. They use it in the manufacture of cigars, smoking tobacco, and snuff. The best grades are used for cigar wrappers. The common leaf is used for cigar filler and binder. Poorer grades are used in making smoking tobacco and snuff. Spain imports common and medium grades of lugs from western Kentucky and uses them for fillers for cigars and for smoking tobacco. Germany, second to Great Britain in the importation of Kentucky tobacco, buys Green River filler and the dark brown tobacco of the Clarksville, Tenn. district. They use it principally in the manufacture of plug tobacco and in German spinner. Several other countries of Europe and Africa import Kentucky tobacco in limited quantities.

A comparison of the annual production of tobacco in Kentucky

with that of other leading tobacco-producing States and also the total production of the United States, demonstrates very forcibly that Kentucky is destined to be the center of importance in the tobacco industry of the United States for many years to come. Statistics from the Yearbook of the Department of Agriculture show that Kentucky produces on the average 267,633,630 pounds annually, while North Carolina and Virginia, the two states next in importance, produce jointly 221,866,435 pounds annually. From these figures it will be seen that Kentucky produces in round numbers 45,000,000 pounds annually more than the combined production of these other two States. Again, she produces more than one-third of the entire output of the United States. She averages 325,948 acres annually, which is more than one-third of the acreage of the entire United States. The average farm value of the tobacco crop in Kentucky for the past six years on December 1, was $16,439,538, which is double that of any other State and one-fourth of the farm value of the entire crop of the United States.

There is some question as to whether Broad-leaf Stand-up Burley, Hanna's White Burley, Red Twist Bud, etc., should be regarded as varieties of White Burley tobacco or only as types of the original Brown County (Ohio) White Burley. In this discussion we have chosen to speak of them as varieties. There are a dozen or more varieties of Burley tobacco with physical characteristics predominant, grading from a rather narrow-leaf drooping plant to a broad-leaf stand-up plant. The same may be said of the dark tobacco in western Kentucky and Tennessee.

In the White Burley district, we have varieties known as Red Twist Bud, Broad-leaf Stand-up, Hulette's, White Twist Bud, Narrow-leaf, Hanna's, Hope's Stand-up, Renacher's Stand-up, etc. In the dark tobacco district, there are varieties known as Little Mammoth, Yellow Pryor, Blue Pryor, Little Yellow, Bunch Talley, Improved Bunch Talley, One Sucker, Boyd, Thickset, Madole, Oronoco, etc. These varieties have, no doubt most of them, taken their names from some physical characteristics of the plant or from some man who has given some attention to developing by selection certain features in the growth and habit of the plant. With such a great number of varieties of tobacco grown and variations even within the varieties, there is ample opportunity for one to substantially increase his net earnings by judiciously selecting the variety of tobacco to plant.

TOBACCO-BREEDING EXPERIMENTS IN KENTUCKY.

Extensive experiments in tobacco breeding have been made in some of the Eastern and Southern states, notably Connecticut, Maryland and Florida, which have resulted in substantial improvements of the tobacco plant. Mr. A. D. Shamel found that plants which had their flowers self-fertilized produced seeds which gave a more vigorous offspring than was obtained from plants which had their flowers cross-fertilized with pollen from the flowers of other plants within the

variety. In two instances, he observed that crosses between two distinct varieties gave an earlier germination of seed, a more vigorous growth and the property of resisting drought better than either of the parent varieties. His discussion of this subject may be found in the Yearbook of the Department of Agriculture for 1905 (pages 377-392). In all of the experiments that have been conducted on tobacco breeding, the results thus far obtained all agree that by complete in-breeding and careful selection of the best parent plant for seed, a more uniform crop may be had and the quality and quantity may be materially improved. The very gratifying improvements that have been obtained elsewhere, and the possibility of similar accomplishments in this district, have stimulated the Secretary of Agriculture to extend the Department's investigations into this territory.

Previous to the year 1906, experiments on tobacco have been conducted on the Experiment Station farm along the following lines: The effect of the use of various quantities of Paris green on tobacco worms; testing the value of fertilizers; a comparison of the side-by-side row test of the relative merits of the different varieties of White Burley tobacco; and hybridization of White Burley with Connecticut Havana, and White Burley with Sumatra. The question of killing worms by using Paris green does not in the strict sense pertain to the improvement of the tobacco plant, but, seeing that it was fast becoming an important factor in the production of tobacco, Professor Garman carried out a series of experiments to ascertain at what strength the application of Paris green was most effective, and at what age the worms were easiest to kill. He found that strong applications completed the destruction of worms in fewer days than did weaker ones. He also found that, whereas the small worms were killed in 4 or 5 days, it took 8 or 10 days to completely kill out the grown ones. A report of this work is published in Bulletin 66 of the Kentucky Station.

In our fertilizer experiments, it was found that by applying potash fertilizer, and especially potash with nitrogen on our land, located in the limestone region, we can substantially increase the yield. The soils of western Kentucky are very different and require, in addition to those elements already mentioned, phosphoric acid. A report of this work is found in Bulletins 63 and 66 of the Kentucky Station.

In our comparisons of the relative value of the different varieties of White Burley tobacco by the side-by-side row test, covering a period of several years, there has been considerable difference in the quality and quantity of the tobacco produced. To illustrate: Last season in a test of 11 varieties of White Burley grown under as nearly uniform conditions as were obtainable, the maximum estimated yield for a variety was 2137 pounds per acre. The minimum estimated yield was 1479 pounds per acre, giving a difference of 658 pounds per acre. It is important that one should not lose sight of the improvement of the quality in his attempt to increase the yield, since they are both obtainable. These extreme variations as to both quality and

yield impress us with the importance of improving the better varieties and eliminating the poorer ones until we approach a uniform type, giving an article which is in the greatest demand.

The creation of new varieties has been very limited in the Kentucky work. However, we have a few hybrids which have been grown for three years. Thus far, they are inferior to the White Burley parent and superior to the Connecticut Havana and Sumatra parents, for a plug or plug-wrapper tobacco.

Three years ago Doctor M. A. Scovell conceived the idea that he might develop a cigar wrapper by introducing into the Stand-up Burley some Sumatra blood. This was done by allowing the flowers to develop under bag on both Stand-up Burley and Sumatra plants. before the female part of the Burley plant was ready for the pollen dust, the anthers, or male parts, were clipped out with a pair of scissors. About two days later, when the pistil, or female part, was ready to be fertilized, anthers, or male parts, were taken by hand from the Sumatra flowers and dusted on the crown of the Burley pistil. Seed pods were successfully set, giving a cross, the seed of which were one-half Stand-up Burley and one-half Sumatra. The hybrid obtained from this cross, though not very promising the first year, showed a decided improvement in the second crop.

Following up these experiments this year, the crosses were several days earlier than the parent plants of Burley. In fact, they were earlier than any of our recognized standard varieties, which result verifies similar results gotten by Mr. Shamel and others. Last summer, an arrangement was made between the United States Department of Agriculture and the Kentucky Experiment Station, by which co-operative experiments were commenced. We are following the breeding methods as outlined by the Department, and which are in a general way as follows:

SELECTION AND CARE OF SEED.

The method of selecting and caring for seed as practiced by Mr. A. D. Shamel, of the United States Department of Agriculture, with experiments conducted in the Connecticut Valley, and which we found to be practical and successful in our operations this summer, is as follows: Go over the field carefully before topping time and select quite a number of plants which approach nearest the ideal and continue to do this during the first topping. Label the plants so selected with a tag or strip of cloth, so that they will not be topped by oversight. By this time one will have several times as many heads selected as he will actually need. As the plants develop, undesirable features in some of them will become prominent. For example, one plant might develop a coarse venation and badly crimped leaf; another might develop the condition known as mosaic or "French." In such cases it is best to top the plants so affected and prevent them from making seed. This elimination might go on not only throughout the growing season, but after the crop has been housed, cured and fermented. It

will be found that an interesting comparison can be made between the leaves of the different plants as to elasticity, color, texture, weight, and, in the case of smoking tobaccos, as to their burning quality. By having the leaves and the seed heads properly labeled, we can take for seed only those which come from the plants having the fewest defects.

PROTECTING THE SEED HEADS FROM CROSS FERTILIZATION.

Too much stress cannot be placed on the importance of using the greatest caution in selecting and bagging the very best plants for seed. By controlling the fertilization of the flowers perfectly, as will be explained in the following pages, one may expect the offspring to have the same general shape, texture, number of leaves, in fact all of the characteristics of the parent plant.

Cross fertilization brought about by insects carrying the pollen from one plant to another, is apt to be harmful, in that it has a tendency to break up desirable varieties into many types. It is brought about in the following way: The bees in their search for nectar visit the flowers on a number of plants. As they crawl in and out of the tubes of the corollas, they pass over the anthers which have recently discharged their pollen, the fertilizing element. Some of these fine grains of pollen become attached to their bodies and are carried to other plants. On entering the tubes of the flowers of these plants, some of those pollen grains that were brought from other plants, are brushed off on the sticky surface of the pistil, the receptive part; this starts a growth which fertilizes the ovules at the base of the pistil, and the seeds thus produced are a cross. In the case of tobacco, when the pollen is brought from an inferior plant, the hybrid produced will be of an inferior quality. Again, if the pollen is brought from a plant low in vitality, the crop of tobacco grown will have a tendency to degeneracy. This can be avoided by protecting the flowers in the following way as practiced by the Bureau of Plant Industry: Strip off carefully the heads and suckers from the "crow foot" down some distance. Then just before the flowers begin to open, procure some light but strong paper bags, about the 12-pound size, such as are ordinarily used at groceries, and slip them down over the seed heads and tie below.

If we should have a very damp season, there might be some danger of the seed molding in the pods on account of an excess of moisture that is retained in the bag. As a safeguard against this, it is advised that the bags be punctured with a sewing machine needle to admit the air.

For the first few days after the bags have been placed around the heads, they must be slipped up frequently to accommodate the rapid growth of the shank of the seed head. It is desirable, though not necessary, to occasionally remove the paper bags and shake out the withered flowers, and then replace the bags as before. It has usually been the custom of experimenters to allow the bags to remain over the heads till, and after harvesting the seed, though we got splendid and

yield impress us with the importance of improving the better varieties and eliminating the poorer ones until we approach a uniform type, giving an article which is in the greatest demand.

The creation of new varieties has been very limited in the Kentucky work. However, we have a few hybrids which have been grown for three years. Thus far, they are inferior to the White Burley parent and superior to the Connecticut Havana and Sumatra parents, for a plug or plug-wrapper tobacco.

Three years ago Doctor M. A. Scovell conceived the idea that he might develop a cigar wrapper by introducing into the Stand-up Burley some Sumatra blood. This was done by allowing the flowers to develop under bag on both Stand-up Burley and Sumatra plants. before the female part of the Burley plant was ready for the pollen dust, the anthers, or male parts, were clipped out with a pair of scissors. About two days later, when the pistil, or female part, was ready to be fertilized, anthers, or male parts, were taken by hand from the Sumatra flowers and dusted on the crown of the Burley pistil. Seed pods were successfully set, giving a cross, the seed of which were one-half Stand-up Burley and one-half Sumatra. The hybrid obtained from this cross, though not very promising the first year, showed a decided improvement in the second crop.

Following up these experiments this year, the crosses were several days earlier than the parent plants of Burley. In fact, they were earlier than any of our recognized standard varieties, which result verifies similar results gotten by Mr. Shamel and others. Last summer, an arrangement was made between the United States Department of Agriculture and the Kentucky Experiment Station, by which co-operative experiments were commenced. We are following the breeding methods as outlined by the Department, and which are in a general way as follows:

SELECTION AND CARE OF SEED.

The method of selecting and caring for seed as practiced by Mr. A. D. Shamel, of the United States Department of Agriculture, with experiments conducted in the Connecticut Valley, and which we found to be practical and successful in our operations this summer, is as follows: Go over the field carefully before topping time and select quite a number of plants which approach nearest the ideal and continue to do this during the first topping. Label the plants so selected with a tag or strip of cloth, so that they will not be topped by oversight. By this time one will have several times as many heads selected as he will actually need. As the plants develop, undesirable features in some of them will become prominent. For example, one plant might develop a coarse venation and badly crimped leaf; another might develop the condition known as mosaic or "French." In such cases it is best to top the plants so affected and prevent them from making seed. This elimination might go on not only throughout the growing season, but after the crop has been housed, cured and fermented. It

duction of foreign varieties will be features of the work, the objects being to eliminate the poor varieties which are now being grown, and if possible to introduce something better than is being grown at present. One is impressed with the possibilities of such an undertaking when he reviews the great number of varieties or types of tobacco that are at present grown in this district.

Announcement was made that McIlvain Bros.' exhibit of fine breeding horses was postponed on account of the bad weather until Friday.

Whereupon the Convention adjourned to meet in the Board of Trade Auditorium at 8 o'clock p. m.

WEDNESDAY EVENING, JANUARY 16—GENERAL SESSION.

The American Breeders' Association met with the Ohio State Farmers' Institute in the Board of Trade Auditorium, Mr. Charles W. Ward, Chairman of the Plant Section, in the chair.

The first thing on the program was music by the Angelus Ladies' Quartette.

Chairman WARD. We will now have the report of the Committee on Breeding Corn, which will be presented by Mr. J. Dwight Funk, of Shirley, Ill.

REPORT OF COMMITTEE ON BREEDING CORN.

By Mr. J. DWIGHT FUNK, *Shirley, Ill.*

I want to make a little explanation in regard to this report. I do not intend to go into any description of breeding methods, but will simply make a sort of summary of the data that I have secured by inquiring into the different methods throughout the United States. It was a more or less difficult job to know just how to do this work, but I adopted a plan that brought forth some information. I suppose all of you heard the lecture this morning by Professor Williams, on Methods of Corn Breeding. The method laid down by him has my hearty approval, with one or two exceptions, and I would like to add a few suggestions on that line. But before I go into that to any extent I want to recommend to the American Breeders' Association that they instruct the Committee on Corn Breeding to organize a National Association of Corn Breeders, and a national registration for corn breeding, the work to be carried on by selecting not more than a dozen or twenty men at first, who must be progressive and advanced

corn breeders; and that when this work is under way we take in all those who are breeding varieties that have some reputation. I do not refer to corn breeders whose breeds have no records of performance behind them, but let that be the only consideration upon which a variety shall be admitted to registration. In order to do this we should have a secretary who will devote his entire time to this work. In this way we will be able to give the purchaser of seed corn a reliable source of information, one that can be absolutely depended upon; and we will do away in time with the so-called breeder of corn who advertises a pure breed with such and such a pedigree, and sends out corn that comes from no better place than his neighbor's crib.

Now as to the methods: Professor Williams follows the ear-to-row system, selecting what I call "champions," the greatest yielders, and retaining in the first instance part of the seed planted in those rows. The next year he plants only the champions. He brings together the champion yielders of the year before. Two of these he detassels and allows to be fertilized from the other. In this way he controls not only the dam—the plant from which he gathers his seed—but the sire as well—the fertilizing plants. I would suggest in addition to this the breeding of individual plants, that is, using one or more ears as dams and using only one sire, and keeping a record of our matings. Of course, we cannot hand pollinate the ear as well as nature can do it; but we can tell in the fall at least the general formation of the ear; and in many instances we are going to do pretty good fertilization. Many of these matings will prove to be either worthless dams or worthless sires; but when we do find an exceedingly good dam, that is, a good large ear that was fertilized by an exceedingly good sire; that is, a plant that produces a fine large ear, then we have something as a basis to work upon; we know absolutely that the kernels of that ear were fertilized by a good sire. If we do not make these individual matings we know that these sires were fertilized from one of the champions of the year before, and some of the plants produced from that champion; but there is great variation with those old champions. There are stalks that will produce inferior ears, some that will produce mediocre ears, and some, good ears. We have no absolute knowledge as to the fertilizing powers of these ears that we get.

I will not hold your attention any longer, because I know you want to hear this lecture. I hope that the American Breeders' Association will adopt the resolution that I have submitted to it, and I hope that all the breeders will approve of it, because I think in that way we will secure some financial results.

Chairman WARD. The next number on the program is the report of the Committee on Breeding for Dairy Production, by Mr. A. J. Glover, Ft. Atkinson, Wis.

REPORT OF COMMITTEE ON BREEDING FOR DAIRY PRODUCTION.

By Mr. A. J. GLOVER, *Ft. Atkinson, Wis.*

Before I proceed to make my report, it is really necessary for me to say a word about it in order that I may not appear ridiculous. I am a member of the Committee on Breeding for Dairy Production, and I prepared a few paragraphs and sent them to the chairman of this committee. Day before yesterday, I received the same back again, the chairman stating that he would be unable to attend, and that I had better present it to the meeting. I have had no time to revise it, and have not had time to prepare a paper. You will therefore understand that what I have here is a suggestion, and nothing conclusive, and that the few thoughts I have to offer lack continuity. When I was asked to make my report to-night I consented, because I thought I had a few things here that would be valuable for the dairy breeders and perhaps breeders of other live stock to consider.

BEAUTY AND UNIFORMITY VS. RECORDS.

Some of the breeders at the present time are breeding largely to animals making the biggest records and with little regard to uniformity and beauty, while too many pay but little or no attention to records but put their entire efforts upon producing stock of beautiful markings and fancy points. Of course, uniformity and beauty have no value so far as the production of the animal is concerned, but is there not something more to breeding than simply getting a type of cows that will produce butter fat and milk economically?

To be useful is the primary aim of life, but that does not mean that the creature must be ugly looking and ill-shaped. In breeding, our chief object should be to breed animals that are large producers, but fancy points should receive some consideration. The question is: How many points out of 100 should be given the productive powers of the animal, and how many to breed characteristics, or to conformance with certain standards outlined by the different breed associations.

This is a point well worth considering even though the primary object of breeding dairy cows is to produce those that are capable; but we must not lose sight of the fact that admirers of fancy stock are willing to pay a long price for the animal that not only rewards him bountifully at the pail but also pleases his eye.

SHORT AND FORCED TESTS.

Too much emphasis has been laid upon forced tests—such as the weekly, 30-day, and those made at our expositions. These tests show what it is possible for a dairy-bred cow to do in a short time, but they do not reveal her true ability—that is, to produce large yields of milk

and fat for a series of years, and also produce strong and talented dairy animals. In other words, it is very doubtful to me whether these tests, like those at St. Louis, advertise our dairy cattle in the proper way. For example, perhaps a good-intentioned, but not well-informed man makes up his mind to breed Jerseys, because they won at St. Louis, and he makes a few purchases, regardless of the ability of the animals. This man, to a certain extent, will expect his Jerseys to do as well as those at St. Louis, and if they do not he is disappointed.

On the other hand, these tests being a great deal like a horse race, the majority of dairymen that read of the results are not stimulated to get better dairy stock, any more than they are led to believe that they should raise trotting horses, because a Dan Patch paces a mile in 1.55 and sells for $60,000. They think that this class of cattle is beyond them, and, therefore, they never take interest in them.

Furthermore, too many animals are made useless through the excessive work that they are called upon to do in a short time. Some of the best cows at the St. Louis Fair are now worthless, and their blood lost to the dairy world, because of this test. Is there not some other method that this committee could suggest that will be more effective in getting dairymen to see the importance of purchasing, keeping, and breeding better cows?

WHAT REVEALS PREPOTENCY.

I wish we could find some data to work on for estimating and teaching the outward indications of prepotency in males. This is the crucial test of their value, yet no one seems to be able to point out how it may be determined.

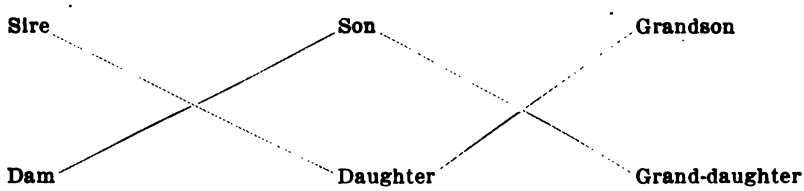
The Guernsey Cattle Club, in their new scale of points have gone further under the lead of W. D. Hoard in the consideration of prepotency, constitution and temperament than any other body of breeders in the United States. Maybe we could do some profitable work along these lines.

HOW SHALL WE BREED TO PRODUCE THE BEST COWS?

It is easier to ask such a question than it is to answer it. The aim of all breeders should be to produce superior cows. It is quite generally believed that daughters take after their fathers and sons after their mothers, in what might be called "prepotent heredity." Now, if this be in the main true, most breeders are working against the law in their efforts to breed on an improving and upward grade.

They pay much more attention to the quality of the cow, as the parent of heifers, than they do to the bull. The true working of that law would be to the effect that a good cow will reproduce her good qualities, not so much through her daughters as through her sons, to be shown finally in her grand-daughters.

A diagram of the Darwinian law of descent would be like this:



It is important that both the dam and sire should be high class animals. But in the production of good heifers, is it not of more importance that the sire should be richly bred? Who can say with certainty?

THE DAUNCEY THEORY.

No greater breeder of dairy cattle ever lived than Mr. Philip Dauncey, who developed the Rioter family of Jerseys. His main object in breeding was to create an animal of great strength, in constitution, and capable of producing large yields of milk. He had the faculty of mating animals to produce his ideal, but unfortunately for breeders, this wonderful gift he took with him to the grave. We have, however, seen the results of his work and by this means have been able to judge the kind of animal that he developed.

Mr. Dauncey believed in coarseness rather than in fineness of physique; coarse hair, heavy bones, thick skin, and a coarse head were considered by him indicative of bodily vigor and a constitution that was capable of resisting disease. The ugly looking head is one of the striking characteristics of the Rioter family, which have been noted far and wide as wonderful producing and strongly developed animals.

In the scientific breeding of dairy animals such points as the above should be noted, and in due time there would be tabulated data, which would suggest or indicate whether coarseness of bone, head, and hair, has anything to do with bodily vigor and a disease-resisting constitution.

WHAT REVEALS CONSTITUTION.

It is generally accepted among teachers of animal and dairy husbandry that depth and width of thorax are indicative of great lung capacity and large hearts. Too frequently is it said that dairy cattle have not the constitution that the beef animals have, because they have less heart girth. The measuring of the size of lungs in both the dairy and the beef animals has been mostly from external observations. In Bulletin No. 81 of the Iowa Experiment Station, the weights of the hearts and lungs of 4 dairy and 4 beef steers are given, and I reproduce them in the table on the following page.

From the table it will be seen that the dairy steers have considerably larger lungs and about the same sized hearts. If the computation is made, per thousand pounds live weight the lungs and windpipes of dairy steers are 54.6 per cent larger than those of the beef steers and the hearts only a trifle larger.

Since so few animals are brought into this calculation I do not feel like laying too much stress upon it. If these figures be true, some other test must be applied besides external observation and measurements in judging the lung capacity of the animal, because, as

Comparative Weights of Heart and Lungs in Dairy and Beef Steers.

Class.	Breed.	Hearts.	Lungs and windpipe.
		Pounds.	*Pounds.*
Dairy steers	Jersey	4.0	10.0
	Jersey	4.5	10.0
	Holstein	3.5	11.0
	Holstein	1.5	8.5
Average		3.4	9.87
For each 1000 pounds		2.89	8.42
Beef steers	Hereford	3.5	6.0
	Hereford	6.0	8.0
	Angus	2.5	6.5
	Angus	3.0	7.5
Average		3.7	7.0
For each 1000 pounds		2.88	5.46

a rule, the beef animal is larger in heart girth than the dairy animal. Would it not be well for some experiment station to take up this work and give us more data upon the comparative sizes of the heart and lungs in the dairy and beef animals; also determine whether the size of the lungs and heart is indicative of a strong constitution. Dauncey laid great stress upon coarse hair, bones, and head; Hoard thinks strong abdominal walls and strong navel development indicative of a vigorous constitution. Here is a field for work.

PRODUCTION AT THE PAIL AND PRODUCTION OF THE WOMB.

There seems to be a tendency among many of the very highest producing dairy cows to become barren, or, at least, be poor or irregular breeders. It is important that the blood of the best animals should be

transmitted to their offspring, and in turn through their progeny reproduce themselves if the most desirable qualities, of the best dairy animals, are to be maintained and handed down to the coming generations.

Through the anxiety to make large records with the phenomenal cow, she is often overfed, which from all indications not only injures her digestive organs, but also her powers of reproduction. Overfeeding may be the principal cause for barrenness and irregular breeding. Who can say?

Perhaps another reason may be the high development of the mammary gland, a condition which must obtain to have an exceptional animal. The nervous system in the dairy animal is supposed to be more highly developed than in the beef animal. Is it probable that this condition may have something to do with the breeding power of the high-class dairy cows? The udder is connected with the womb by a wonderful network of nerves called the sympathetic plexus and thence to the lumbar region of the spine. It might be inferred that excessive lactation would have a reflex effect on the womb.

YEARLY VS. SHORT TESTS.

I think we ought to emphasize the greater importance of the yearly test of cows over the weekly or 30-day test, for the reason that the short-time test is more apt to tempt men over the danger line. Then, too, the yearly test is a better guarantee of the staying power of the cow and her real producing ability.

The Holstein-Friesian Association have a system of testing cows within 30 days after calving and then again in 8 months. The Guernsey Cattle Club test one day each month during the year. The Jersey and Ayrshire breeders have similar tests. But the largest number of official records are made in seven days, which is too short a time to prove the merits or demerits of a cow.

The system of testing cows 30 days after calving and again in 8 months or testing them once a month, through the year, should be encouraged, for both systems give very satisfactory results.

EFFECT OF FEED UPON HEALTH.

I once had a conversation with the first man to produce certified milk in the United States. He said: "Do you know that I can so feed my cows that I can make every baby that is using my milk sick?" He handed me a number of letters complaining about a certain day's milk, and explained that he had found that that day his cows had been turned from short pasture over into long pasture, thereby becoming more or less sick. This showed that the feed had its direct effect upon the health of the animal and upon its development.

Chairman WARD. Gentlemen, away back, early in the seventies, it was my pleasure to take a trip to California by way of St. Louis and Denver. On the trip from St. Louis to Denver we were astounded

by the enormous herds of buffalo along the line of what was then the Kansas Pacific Railroad. They were so thick at one point that the train was obliged to stop for some little time while the herd was crossing the track at this particular point; and while the train was stopping we saw a gentleman with long hair and a broad brimmed hat, and a couple of Colt's navy revolvers and a Winchester rifle hanging on the outskirts of the herd gathering in his crop. We asked who he was, and some one of the same type on the train said, "Why, that is Colonel Jones—Buffalo Jones."

The buffalo now have all disappeared from the plains. Within the past two or three years I passed over the same road and found that even the buffalo bones had disappeared; but Colonel Jones had not disappeared; he still remains upon the scene. He is endeavoring at the present time to atone for some of his past misdeeds—what we at the present time consider misdeeds, but which everybody considered all right at that time—and he is now endeavoring to replace not the buffaloes themselves perhaps, but some modifications of the buffalo.

He is not only breeding buffalo, but he is crossing the buffalo upon our domestic cattle. He has been kind enough to bring us here a show which I am quite sure will interest you all, and he will give you a talk upon the work he is doing.

By the way, the Colonel tells me he does not object to being called "Buffalo Jones."

BREEDING CATTELO.

By COLONEL C. J. JONES, *Topeka, Kas.*

[Illustrated by moving pictures.]

MR. CHAIRMAN AND GENTLEMEN OF THE AMERICAN BREEDERS' ASSOCIATION: Your Chairman has given me a terrible send-off, and I guess I need it. He has introduced me as "Buffalo Jones," but there is one thing that I want placed to my credit, and that is that, when I found that the animals were liable to be exterminated if their slaughter was continued so wantonly, I determined that I would do my part to make amends by making every effort in my power to prevent their final extinction, and I have to my credit over 1500 buffalo that I have bred. That 1500 originated as nearly as I can figure it up from 82 calves, for you must remember that no animal was ever captured alive and kept alive in captivity that was over three months old at the time of its capture. When you capture them over that age they will commit suicide, you never can save them; conse-

quently we had to take the little calves and rear them by the aid of domesticated cattle, or in any way we could. Out of the 82 calves from which our 1500 buffalo originated I captured and saved with my own hands 58 calves; consequently, I think that I have atoned for my part in the extermination to a great extent. (Applause.)

When the Creator brought into existence that mighty continental country, a great empire in itself, bordered on the east by the Missouri River, on the west by the Rocky Mountains, on the south by the Gulf of Mexico and on the north by the Great Slave Lake—a country a thousand miles wide and two thousand miles long—he certainly had to provide animals to live there. So when he looked around on the sixth day of creation and found that he had not an animal of all that were then created that could live in that desert country, not wishing to make anything in vain, he hastily threw together a great black lump, not stopping to polish it down. He breathed into its nostrils the breath of life; and that animal became the buffalo of our western plains. I can imagine that animal saying to the great Creator, "Have I been cast into this great world to perish? Look at my form, this great awkward hump and crooked back all naked, nothing in the world to protect me! Look at this great desert with hardly any grass, only here and there a blade; how do you expect me to dwell upon it and live? Besides, the water is far apart, and I will certainly perish from the fatigue of my constant journeys to it. Then too, the flies will come and devour my flesh; hot siroccos will burn it; the blizzards from the northwest will chill me through; and there will be nothing but death for me and my posterity." All these things and more, I can imagine him saying; and he petitioned the great Creator to send him to some more genial clime where he could exist and be happy. Then I can hear a voice answering: "Peace, be still! Your stomach is large, to be sure, but I will fill it with many manifolds, so that very little food will suffice, and out of that little you will extract a sufficiency. And the manifolds will be so close together that your stomach will pulverize hard substances. I will add an extra rib; I will give you fourteen ribs on each side instead of thirteen; and in that way you can be strong, you can go far to water. Your stomach is large, you can fill it with water; you need not return to the water excepting about every three or four days, instead of every day, and that will make the journey easier. To be sure, the grass is scarce; but then, remember, you must not cut a blade of grass unnecessarily with your sharp hoofs. Walk in the steps of your leader, and thereby make a little narrow path across the plain and back to water. Wherever you need water follow the same trail. And surely if he be a benefactor who causes two blades of grass to grow where only one has grown before, how much more will you be that preserves thousands of blades! The pelting hail will come, the snows will descend upon you, but they will only cause the fur to grow over your form; the harder the storms, the more fur will grow. The bite of your enemies, the flies, will cause great masses of hair to

grow over your head, and these too will protect your eyes. In that way also you will be protected against the blizzards. When your enemies, the rattle-snakes, strike forth with their fangs and try to fasten them in your legs, you can trample their lives out with your feet.

You complain of that great hump. That is your food supply; that you can draw upon in times of extreme drouth and famine. You never will perish as long as that great hump lasts. Because of that extra rib and that great hump that strengthens your back you can go far to water. You will have horns so that you can hold your own with the other animals of the plains."

All these and many other things made the animal so well fitted for its surroundings that it has always been an interesting study to me. Away back in the seventies I was trying to raise cattelo. You folks come here and talk about your fine cattle and what you have done in breeding them. You keep them in your fine barns, you pamper them up and they become big and fat. You feed them with the best food; but with the buffalo the case is different. I would be afraid to try to raise the cattle you talk of here out on the prairies; I could not do it. I got a lot of Texas cattle out there once, and I remember that in 1885, when the great blizzard came, my cattle all drifted to the south, and in the spring of the year I found their carcasses scattered clear from Sante Fe down into Texas, everyone with his head to the south and his tail to the storm. But I could not find the carcass of a single buffalo that had perished from that storm. What a wonderful animal that could stand such a storm that nothing else could survive! About 75 per cent of my cattle perished, and the rest were so poor that I did not dare to start them back until the fall of the year. By that time the rustlers had half of those that remained. I thought, now if I could get some of the blood of those wonderful animals injected into the domestic animals and get the hardiness of the buffalo in the offspring, what a wonderful animal I would have. I had known all about the buffaloes, I had figured out all the benefits of the animal. I started right then after my fast horses, I got my best ponies, and I went to work catching calves. For four years I kept on catching those calves. I got them started, and I will show you some of them, if the young man at the lantern will throw some of those pictures on the screen. (Applause.)

[The lantern slides were now exhibited, Colonel Jones meantime keeping up a running fire of comment, some of which is reproduced below. The stenographer during the display of the pictures on the screen having no light was at some disadvantage, but took notes as best he could.]

There are 600,000,000 acres of the public domain that cannot be utilized with domestic stock.

Here we have full-grown buffalo. This is a young bull about six years old, just coming into his prime, and to be sure it is the survival of the fittest, and the best animal does the business, and his progeny

is like unto the sire. In that way they keep up the quality and increase the stock instead of decreasing it.

When I started to breed cattelo, people ridiculed me; they thought I was crazy. I guess if I had told them what I hoped to do they would have sent me to the insane asylum. I asked Congress to assist me a little. Some fellow got up and offered a resolution to establish a farm for the raising of mules. That showed all he knew about it. Others would say: "What is the good of it? No man should try to improve upon what God has created." Now, Nature has done wonderful things, but can Nature be perfect without the help of mankind? You might say that it is of no use to till the soil, that it should be left as Nature made it. God Almighty made roses, and he made man; but it took man and God Almighty both to make the American Beauty rose, which is so much ahead of the ordinary rose that you can hardly compare them. Man has only commenced in his career of improvement; there is no limit. See this buffalo robe! That is worth more than the skins of half a dozen of your Shorthorn steers. I do not want to detract in the slightest from your fine stock; it is all right, but here is something else that is equal to it and which will be far superior to it in that far away country where we have 600,000,000 acres of land that we cannot utilize unless we can stock it with animals that can live there and thrive. You cannot take your fine animals out there and have them live and thrive; but stock those plains with these animals, and thousands and tens of thousands of people can have happy homes. You want an animal that you can utilize in that country, and not one that will lie down and die. Let us investigate these things. We have to think not only of the United States, but of Alaska where there are hundreds of millions of acres to be utilized. Here, in the cattelo is an animal that has not only got the beef which is the finest in the world, but an animal that will furnish furs that you can wrap yourselves in and be comfortable.

We are also experimenting with other animals, such as sheep. I got hold of some Persian sheep. I trust you know what Persian lambs are. They have large flat tails which carry about 10 or 20 pounds of mutton. They can draw on that in case of starvation, just as the camel or the buffalo does on the hump. They are hardy animals for that western country. That animal had the wonderful weight of 283 pounds at eighteen months old, right off the grass. They carry about as much wool as the ordinary sheep. There is nothing like that mutton in the world.

That is a hybrid (indicating) one-half Shropshire. We have 600 lambs, some three-quarters, some seven-eighths.

We think if we can get a little of the blood of the antelope into our sheep we will have something that can take care of itself. Those antelope are wonderful animals. Before the mating season of the antelope, you will see it running, running for a week, hardly stopping, its lungs expanded to the utmost, its nostrils distended, and every muscle drawn to its highest tension. Thus they give their powers to

their young. Why don't some of you men who are training your horses to fast gaits copy this animal, and get something that will be worth offering to your patrons?

Here are the mountain sheep, animals that dwell above the clouds. I am trying to get some of these now. I want to see if I cannot put some of their hardiness into the domestic breeds, so that I can turn them out on the hills and mountains and let them take care of themselves where tens of thousands are perishing to-day.

Now, Mr. President and gentlemen, I thank you very kindly for your attention. I hope you have enjoyed yourselves. I hope I have said something that will be of benefit to all of you. I bid you goodnight. (Applause.)

On the suggestion of Chairman Ward, the audience gave Colonel Jones a rising vote of thanks and three cheers, which were acknowledged by him with an expression of his most sincere thanks.

After music by the Angelus Ladies' Quartette, and announcement of program features for the morrow, the convention adjourned until 10 o'clock a. m. Thursday, January 17th, to meet jointly with the Ohio State Board of Agriculture.

At the session of the Ohio Board of Agriculture on Thursday afternoon, in addition to the address of Hon. F. D. Coburn who, as the principal speaker of the day, gave a most interesting and valuable talk on "Alfalfa," there was presented a paper by Hon. H. M. Brown of Hillsboro, Ohio, on "Establishing Type in Breeding Animals" which is presented to our members because of its practical and useful application to the work of this Association.

ESTABLISHING TYPE IN BREEDING ANIMALS.

By H. M. Brown, *Hillsboro, O.*

One who writes or speaks, naturally aspires to impress his thoughts favorably upon the minds of those who hear; and in order to do so, strenuous effort is sometimes made to originate something, to create new ideas, or to evolve so-called facts out of eccentric conclusions from false promises, thus misleading the unwary and teaching heretical whims that were better never to have been promulgated.

The writer knows that there is nothing new in the great law of heredity, but it is hoped that a keen observation of the physiological phenomena of reproduction, for a long period of years, may entitle him to speak with some degree of authority on certain phases of the great problem which is the subject before us at this hour.

The same laws govern that governed in the beginning and there is nothing complex or enigmatical to cope with. If we can but eliminate

from our minds that there is occult mystery connected with the business of animal breeding, and bring ourselves to the conviction that form and quality are elements capable of *certain* direction by the human mind, we are ready to comprehend, in a natural way, the simple art of conceiving an idea and developing it through breeding as the sculptor, or any other artist, moulds the materials at hand to conform to the model he wishes to reproduce.

Certain so-called laws of reproduction never need have been taught so far as any benefits we are to derive from them are concerned, and to eliminate them from our calculations in our attempts to breed good animals is an absolute essential.

It is true that in all large fields of inquiry there is a sufficient number of empirical coincidences to make a plausible case in favor of whatever view one may choose to advocate; thus any trumped-up theory may be made to do convincing duty and to carry unchangeable conviction to the minds of the unthinking and credulous, and a succession of mere accidents in the processes of animal breeding may, perchance, be formulated into a so-called law that serves to complicate and confuse to the extent of positive and lasting retardation of the work; and I do not think this will end until those of us who are responsible as teachers for the education of the masses consent to simplify matters a little and get down to a common-sense basis for the theory and practice of the members of our craft, that will have one common starting point and one common goal to be reached, sooner or later depending wholly on the diligence exercised by the director of the work and not upon some mysterious and transcendently superior knowledge one may possess over another of equal education and experience.

The law of atavism is but another illustration of the truth of the dictum that "like produces like," for when an animal takes after a remote ancestor is it anything else than a proof that there were enough of the elements of that ancestor in the forces at work to produce another animal in its own image although far removed? If the progeny is a result of reversional heredity the fault lies with the breeder if the quality is bad, for the animals in the pedigree are prescribed by the director of the processes, and if bad elements necessarily crop out in the product he has only himself to blame for introducing any animal, which, when reverted to further along will disqualify the progeny of nearer ancestors of outstanding merit.

In theory that which I have just stated is regarded as sound reasoning, but in practice it is quite out of the question for many breeders to have under one management a herd, of cattle at least, so long as to be able to eliminate all objectionable elements from the pedigree of his stock, and in case he did succeed in doing so there would still be disappointments that would come under the head of accidents of nutrition or disease, or something else, that could not be regarded as conforming to any law of breeding, to disturb his rightful expec-

tations. This brings us to a consideration of the so-called law of variation.

I am aware that I am taking some chances in *this* presence when I state that such a law could not exist. The very fact that there are varying phenomena from one thing to another, and many different things together, precludes the possibility of a law governing such manifestations, for natural laws are not of such fickle character as to manifest themselves without system or reason of any kind. The variation can usually be placed under the head of atavism or reversional heredity, or to accidental interference with the even workings of the well-known law of "like produces like."

Such disturbances may result from bad feeding, emotional shock from fright, to continuous agitation, from rough handling throughout the formative period, or to unsanitary surroundings and consequent disease, making it impossible to obtain the best results based upon the only real breeding law we have, viz., that of "like produces like."

Variations occur in animal breeding, as well as in that of plants, at frequent intervals, but no one, I think, will be bold enough to try to maintain that such manifestations are governed by law when upon investigation it can be shown that there is no consistency, rule, or regularity about such manifestations, and usually they can be traced to anarchistic violation of the simple laws we know *do* exist, and from which all the years that have gone before have failed to show any permanent and fixed deviation.

However much the method may be justly mistrusted and feared, we must, after a long century of hard work and experimentation, acknowledge that to in-breeding, exercised with the greatest care and judgment, we owe our greatest triumphs in the art of breeding to a high standard of excellence all along the line.

The list of preeminently great breeders of the world is limited as to length, it is true, but there is not one among them that has attained his reputation as a great breeder from products that are the result of a series of violent out-crosses, whether with cattle, sheep, horses, swine, dogs, or other domestic animals or birds. Yet I think that out-crossing is just as successful as in-breeding, if the out-crosses possess the exact type and other desirable qualities sought in the building up of a herd or flock in which form, feeding quality, and constitution are the objects striven for in the ultimate result; for those are the characteristics that have made all the preeminently satisfactory herds, and such a happy attainment has been reached in the main by breeding the type in and in; and when we say "type" we mean it in its broadest sense, which would include form, style, constitution, feeding qualities, and disposition.

It is well known that if two animals to be mated possess in common a certain characteristic—other requirements being normal—that same characteristic will likely be accentuated in the offspring, and if the two possess universally good characteristics the result of this mating will likely be all that is desired. On the other hand the result of

such mating may possibly be a product that is greatly inferior to either of the two immediate ancestors, which may be attributed to bad elements in the remote pedigree and which have cropped out, according to the law of atavism, or reversional heredity.

Sir Henry Maudsley once said "The individual is not responsible for the tyranny of his organization, and the great-great-great-grandfathers may be responsible for the character—physical, moral, and mental—of the subject under consideration."

Thus it can be seen at a glance how important it is to look well to the pedigree in the selection of an animal; but most sticklers for pedigree slacken their diligence one generation too soon.

Good pedigree means that all the sires and dams appearing in it are creditable animals; but one usually forgets to count that the animal selected is also a part of the pedigree, and is to be a part of its extension; and if it falls short of the wanted excellence of its ancestors it should be cast aside, remembering that the selection of a part of the mass of material entrusted to that one carries with it a responsibility which, I fear, is not fully appreciated by the average breeder of this age.

The excellence or non-excellence of generations of cattle and the fortunes of generations of men may depend to a remarkable degree upon the character of one sire or one dam incorporated into the material formula of a line of breeding. Hence, it will be seen how important it is that nothing but honest, earnest, and persistent endeavor should be made in such work, to the end that the breeding processes will cease to be a business that goes two steps forward in the hands of one, and then three steps backward in the hands of another, and thus never attains an ideal for want of concerted movement.

It will be seen that the writer is a believer in pedigree, but, mark you, the kind of a pedigree advocated is that I have just described. There is another and a different kind of stickler for pedigree of an altogether different kind from that which I advocate, viz., the fashionable pedigree, in which it is a secondary matter that the animals composing it shall be of great individual excellence; that they contain much of the blood of the founders of the line is all sufficient; and men have gone wild over, and spent fortunes for, a pedigree that, in many instances, is worse than worthless paper, that will inevitably bring disaster and failure upon those who can not realize the pitfalls into which they are being led by designing, speculating fortune hunters that infest the household of every breeding fraternity at longer or shorter intervals, but sufficiently frequent and for a sufficiently long time to interrupt the complacent and even progress of the work in such a marked degree as to make incumbent upon the honest ones to start new at the end of each ruinous climax thus engendered.

A fashionable pedigree is usually a pedigree that has been developed in the following way: An honest, capable, and careful breeder begins with good cattle to improve them by a series of careful selections of

breeding animals. If good judgment is used each successive generation is an improvement over the preceding, and the fixing of an individual type finally is one of the crowning accomplishments in that particular herd. Show-yard successes follow and ultimately the animals of that herd are made fashionable by performance. Now the whole people want them, and the demand is great. The bad ones that have been discarded from the herd for incompetency are picked up by the speculators and put off upon a credulous public at fabulous prices. Those who are fortunate enough to get good ones of the line, in the mad desire to get progeny, are willing to mate these to males of bad pedigree and incompatible type, and it is not long until all the good qualities are dissipated and sacrificed to greed and ignorance, and the whole superstructure, so wisely builded by the originator, is razed to the ground and we have nothing left but a motley crowd of weakened, and bastard scrubs that yet retain the name of the type or strain, and are as salable as ever because the unscrupulous promoters of the fraud find no difficulty in passing them off on the innocent and unsuspecting purchasers until some one has the courage to call a halt or until it gets so bad that even a novice can see through it.

Such is the almost universal fate of the so-called ultra-fashionable tribes of cattle, and the sooner we learn to recognize worth wherever found, and discard want of it wherever found, the sooner we will succeed and the sooner we will make it incumbent upon the unscrupulous to get out of the ranks of honest men and teach them that it were better to ply their nefarious trade along lines that are not productive of such lasting and irrevocable injury.

It is a most gratifying reflection for a breeder to know that, wherever his animals may go, they will be recognized as *his* handiwork. Thus it is frequently said, with unerring precision, "There is a Gibson Ram," or a Cooper, or a Mansel, or a Dudding; and with equal confidence and certainty you might hear from the ringside that the animal was bred at Uppermill or that the Ballindallock type is evident from every view point.

I have come to believe that, unless the breeder can conduct his operations so as to place his own peculiar stamp of conformation and of other characteristics upon the animals he breeds, he will fall short of the success sought and that his fame will never reach beyond his immediate environment. To attain that end it must be admitted that in-breeding can but be resorted to to a greater or less extent, for it is quite impossible to get the desired type when frequent and violent out-crossing is the rule.

Having reached the conclusion that in-breeding is a necessity, it behooves us to find a method of doing it that is productive of no harm, if possible, and I believe the possibility has been again and again abundantly proven; yet it will be necessary, from time to time, to introduce new elements for the purpose of avoiding the weakening of constitutions known to result from too long-continued incestuous mat-

ing. The new elements that are to be brought in should always come from the sire's side.

I do not deem an out-cross a violent one, even though not the most remote relationship exists, if only the out-crossing animal is identical in type, rendered so by some generations of ancestors of similar conformation and character. Such out-crosses are most desirable, and, if the breeder could always obtain them, there would be no necessity for in-breeding. On the other hand, with any animal of the line, however near he may be related, if the type is wrong, the cross is more or less violent.

Type to type, with an ever-watchful and zealous effort to improve health, constitution, feeding qualities, and breed character, is the motto that I would adopt, and let relationship take care of itself in the main; but, when possible, I would introduce unrelated animals to compromise with the prejudice we all entertain regarding near relationship; but I would never sacrifice one single iota of the original purpose of individual stamp for an out-cross that may do incalculable harm.

I have been wholly unable to see how animals of perfect health, perfect digestion, perfect form, perfect disposition, perfect reproductive powers and prepotency, can deteriorate, however much they may be in-bred, if only all those attributes are kept intact by proper care and attention, always discarding those that are not so endowed, if by accident they happen to be produced from the breeding herd.

The most successful flock of Lincoln sheep I ever bred were lambs out of ewes with a common sire. I hazarded the risk because the ram was great in all essentials and very prepotent. Those lambs were subsequently bred to unrelated sires and the best results followed, in that the most desirable attributes of the old sire were manifest in the out-crossed offspring; and the flock has continued to this day to breed back to *his* type, leaving out the individual make-up, in a great measure, the characteristics of the intervening sires; and I have recently made up my mind to cast about for a son of the old ram, in the hope that I may more securely fasten his good points onto the flock. It is needless to say that that son must possess unmistakable evidence of perfect health and vigor of constitution.

The wonderfully beautiful type of the Shropshire sheep of the present day, is due in great measure to a system of in-breeding, and I defy anyone to successfully deny it.

It is a dangerous thing to select sires at haphazard; and I think I would advise, if I advised at all, that the breeder with ambition to be a leader should not go outside his own herd to get them; but I would have him deliberately set about to breed them for his own use out of the best he has at hand from animals whose capabilities, breed qualities, and prepotency are a part of his intimate and certain knowledge, based upon a close scrutiny for years together.

We will suppose that the individuality and specific type that is

fixed and regarded as a personality of the breeder himself are a recognized entity, and the question of new sires to be selected is claiming a careful consideration. The continuance of the excellence of the herd becomes a knotty problem and is not easily solved by the careful man. The man with no special insight as regards the possibilities could settle it at once by simply taking a collection of pedigrees as set out in the catalogue of a pending public sale, and select from it a large number of names that have been made famous by reason of a near relationship to some celebrated foundress of a family, and, if he happens to be a busy man, simply send an unlimited bid to the auctioneer, without regard to individual merit or anything else except to be sure of the fashionableness of the pedigree. Such a preposterous thing I have known to be done on more than one occasion, and, as would be expected, with most damaging results.

No sire should be installed whose ancestry on both sides, for several generations, is not well and thoroughly known by the purchaser, and that knowledge is usually only possessed by the breeder, regarding the animals composing his own herd.

To buy a sire on inspection is almost as bad, for, though he may be all that is desired within himself, who can tell without certain knowledge what were the individual constitutents of his ancestry?

If they were bad in part the unerring law of "like produces like" will force, beyond the shadow of a doubt, a composite reproduction of all his hereditary qualities, good or bad, regardless of his own apparent excellence.

I would then select the sires from my own herd something after the following plan: Supposing the herd to be well along in its development and the type well fixed; I would select two or more of the cows from it that are the best breeders, the most prominent, and possessing, as nearly as possible, all the other desirable traits, being animals thoroughly known and understood, and the progeny of a line of animals thoroughly known and understood by the breeder as possessing no physiological tricks or short-comings, but substantial and laudable breeding traits which can be relied upon as proven by a long trial. I would then cast about for a sire of equal merit in so far as it is possible, concerning which I had, as nearly as possible, equally intimate knowledge along all the required lines. Disregarding distance, delay, and expense, either by purchase or otherwise, I would mate them to him and continue the mating until they had produced bulls to my liking, which I would breed to the herd in divisions, subsequently crossing the progeny one to the other, without thinking of the relationship except in the first instance, which should be, as far as possible, of unrelated blood. That plan I would carry out whether I were breeding cattle or sheep.

I must confess that my experience with swine, extending over a period of several years, with as many as four of the leading breeds, would cause me to hesitate to advise, with refernce to them, a very

long-continued system of in-breeding. Not that the type would not be maintained, nor yet that the general excellence would not be perpetuated; but, according to some leading theories of reproduction with animals that bear at such frequent intervals and in such numbers, there is an incomprehensible biologic inhibition on the continuance of normal prolificacy, brought about by incestuous mating that does not otherwise become manifest and which may be corrected at will by a judicious complete out-cross. While I am not certain on that point, I am disposed to believe that there is something in the theory. Yet it is preeminently true that the great successes in the swine show-yards of all countries are the results of very close breeding to the line; and I think that, upon investigation, it might be proven that the fault regarding lack of prolificacy, may be accounted for on the ground that individuals of small litters have been selected because of their great excellence due to a better start and quicker growth which most small litters attain as the result of better nourishment.

As in other instances, it would not surprise me to find that all the reputed disastrous results of the plan could be effectually eliminated by a system of wise selection, carefully carried out, covering all points under discussion.

It must be remembered that each and every characteristic of man or animal, whether naturally attained or the result of accident, may finally become an element in the hereditary attributes of the race, in a modified degree. Thus, a physical quality attained by accident may become a fixed entity in the offspring, under certain favorable conditions. This has been proven in practice a sufficiently large number of times to establish the truth of it, and we can no longer ignore the fact.

We have it from abundant and good authority that all so-called variations are pathological and not naturally produced by law; but according to the law that "like produces like" they will be reproduced with painful certainty, which includes all weaknesses of whatsoever kind, disposition, milking quality, weak digestion, delicate constitution, reproductive function, breed characteristics, etc.

But I leave it to all to decide whether or not one will have more of such undesirable traits when breeding to a well-fixed line and type, or when selecting at random from all kinds and conditions of stock unknown to him or to any one else for the sake of crossing to outside blood.

The correct theory of heredity has not, as yet, been worked out, but there are facts which have been empirically established in practice which are the only guiding lights we at present have, and I submit that it is better to follow in the footsteps of the successful ones, disregarding the cry of the alarmists, until we have something more tangible, to show us the way.

THURSDAY AFTERNOON, JANUARY 17—BUSINESS SESSION.

A business session was held at the office of the secretary of the Columbus Board of Trade at 5 o'clock p. m., with Hon. A. P. Grout presiding and Mr. C. B. Davenport acting as secretary. The proceedings were as follows:

The auditing committee, through Mr. Q. I. Simpson, reported as follows:

We, the undersigned, appointed to audit the accounts of the Secretary and Treasurer of the American Breeders' Association, certify that we have examined these accounts and find them correct so far as we are able to check up on the receipts and expenditures. Some receipts as paid checks are still unreturned to the Secretary, but the total financial footings balance.

(Signed) C. S. Plumb,
Q. I. Simpson,
W. E. Castle.

On recommendation of the Council, Mr. Francis Galton, of London, England, was elected an honorary member of the American Breeders' Association.

RESOLUTIONS.

The following resolutions, favorably reported and recommended by the Council for passage, were, on motion, adopted:

Resolved, That the recommendation of the Council that the Secretary of the Association be requested to take a postal card vote of the members on the subject of increasing the annual fee to $2 be concurred in, said recommendation of Council being as follows:

In accordance with Section XVI of the By-laws the Council recommends to the members of the American Breeders' Association that Section IV of the By-laws be amended by striking out "one" before the word "dollar" and substituting the word "two"; and, before the word "membership," inserting the word "annual"; so that Section IV will then read as follows:

"The *annual* membership dues of persons, of societies, and of institutions shall be *two dollars* and shall be payable upon notification of election and annually thereafter."

The Secretary is directed to secure a vote of all members by mail for and against the proposed amendment.

If the foregoing amendment be adopted, the Secretary is also then instructed to ascertain the feasibility of publishing a monthly or periodical journal devoted to the interests and objects of the Association and to be sent to all members in addition to the annual report, and of employing a Secretary, who shall give his entire time to editing the said journal, to greatly increasing the membership of the Association, and to the general promotion of its work.

Resolved, That the number of members of the American Breeders' Association committees be seven.

Resolved, That the Council shall annually choose in session or by mail four members for each committee, designating one of them to be chairman of the committee, and that this committee of four be requested to add the other three members of the committee.

Resolved, That each committee is authorized to organize subcommittees to take charge of the special divisions of the subjects respectively entrusted to said committees.

The following resolution offered by Mr. W. R. Dodson, of Louisiana, regarding "Congressional Free Seeds," approved by Council, was on motion adopted:

Whereas, the National Department of Agriculture now spends a large amount of money in carrying out the provisions of Congress in distributing small packages of free seeds to the farmers of the United States; and

Whereas said seeds do not generally represent strains conducive to the promotion of the best interests of progressive plant breeding and selection; therefore, be it

Resolved, That it is the sense of the American Breeders' Association, now in convention, that it would conserve the best interests of agriculture if Congress should discontinue the present system of distributing seeds that can be procured on the open market, and give the amount of money thus saved to the Department of Agriculture and the experiment stations under the administration of the Department, to be used in improving strains of plants now under cultivation, in originating new and desirable strains, and in importing new species of useful plants, or in other ways that may be deemed feasible for intensifying or originating desirable characters of plants that have, or may promise to have, commercial value in the United States.

The following resolution was adopted, viz:

Whereas the game laws in some States now make no provision for shipment of birds for propagation, or contain unnecessary restrictions which tend to discourage experiments in breeding native and imported game birds; therefore, be it

Resolved by the American Breeders' Association, That this subject be brought to the attention of State game commissioners and wardens and other persons interested, and that they be urged to take such steps as may be necessary to secure the adoption of amendments to existing laws which will permit the capture and shipment (under proper supervision) of game birds intended for purposes of propagation.

Assistant Secretary Mowry read a telegram from Secretary Hays regarding a national co-operative auditing association.

On motion of Mr. Ward, it was voted that the Council be authorized to take the matter referred to by Mr. Hays under consideration,

and to see what arrangements in the matter can be made with other organizations.

On motion, it was voted that it is the sense of the American Breeders' Association that each member take up with his Congressman the matter of the resolution concerning free-seed distribution.

On motion, it was voted that the American Breeders' Association congratulates the Deutsches Gesellschaft für Zuchtungskunde on its recent organization, and extends its best wishes for a long life and effective service in developing the science of breeding.

THURSDAY EVENING, JANUARY 17—GENERAL SESSION.

The Association met in the Board of Trade Building with the Ohio State Farmers' Institute, with Hon. Charles Willis Ward in the Chair.

After Music by the Angelus Ladies' Quartette, the Chair called for the report of the Committee on Breeding Wild Birds, which was submitted verbally by Dr. T. S. Palmer, of Washington, D. C., Chairman, and will appear in a succeeding report.

THE PRESS AND BREEDING.

By Dr. W. I. CHAMBERLAIN, *Hudson, O.*

MR. PRESIDENT AND GENTLEMEN:

On Tuesday afternoon, at the University Chapel we had from Doctor Davenport and Doctor Castle two illustrated papers, or lectures of keen scientific interest and great practical value, because each was based upon months and years of faithful special experimentation and research by a keen and well trained scientific expert; and similar other papers have since been given before this Association that have been of what we call rather non-practical and purely scientific character.

The subject, "The Press and Breeding," assigned to me by Secretary Hays, as well as my entire life work, preclude anything of that sort now. I can give you no new and striking facts in science, but simply the observations, and, I trust, the logical and helpful conclusions of fifty years of work along agricultural lines, and nearly thirty years connection with the agricultural press. By the word "press" I take it Secretary Hays meant the agricultural press, and by the subject "The Press and Breeding" I take it he meant to ask, "What can the agricultural press do to help the breeder, and, conversely, what can the breeders do to help the agricultural press? That, then, is my topic.

First, the agricultural press, through photo-engraving can and does

imprint upon the inner vision of its millions of readers correct concepts of the best types of breeds and individual animals. In this respect it is the greatest of all educational agencies in breeding. That is the only striking thing that I have to bring before you to-night. To me it seems to be a striking thing. Did you ever stop to think that until Daguerre in the early forties by his camera and sensitized plate, harnessed the great sun to do the work of ten thousand times ten thousand artists, and excell them all in accuracy as well as in swiftness—that until then the people at large could have no clear concept of any given thing unless they actually saw the thing itself?

But now, through photography, they look upon the exact features and forms of friends far distant or long dead, and thus they may enjoy foreign travel at their own firesides, with exact concepts of distant famous men, buildings and scenes. I speak within bounds when I say that no invention of the 19th century has done so much as Daguerre's to give correct ideas or concepts of things, or so much to diffuse real fine art throughout the homes of the common people. The old slow work of brush, crayon, pencil, and hand engraving are left, as it were, back in the dark ages by both the swiftness and the accuracy of the sun's work, or that of an artificial light in photography and process engraving. Here, for example, is a large camera with its sensitized plate facing a fine landscape, not too distant, and here is a pencil artist facing the same landscape. In the smallest fraction of a second the sun will reproduce each minutest feature, leaf and twig of that landscape with the most absolute faithfulness and truth, so that when placed under a magnifying glass each minute detail shall appear distinct. By days of patient toil the human artist can reproduce only the main features of that landscape. So infinitely swifter is the infinite than the finite!

I shall presently show further how the sun's power through Daguerre's invention greatly improved can be and is used by the press to advance the breeder's interests.

Let me digress, however, for a moment to show by a single example what photography can do and is doing to advance science in other lines. Here, for example, is a great telescope that will enlarge objects or increase light ten thousand fold. The operator turns its gaze at night upon some dark spot in the heavens where no telescope has yet been powerful enough to discover any remote fixed star, where the dense darkness seems impenetrable. The unerring eye of the telescope having been directed to this spot by the operator, by means of intricate clock work he holds its gaze on that one spot for hours and hours. The dim light, increased ten thousand fold by the telescopic lenses, is focused on a photographer's plate so sensitized that the sun's rays would paint upon it your face or mine in the smallest fraction of a second. Upon this plate thus sensitized the few dim rays of light from this dark area of the heavens are thrown for hours, multiplied ten thousand times by the telescope's vast power, multiplied again by as much as the hours of exposure exceed the fraction of a second. And

what is the result? Why, there are photographed upon this plate dim suns and constellations, so distant and so dim that they have been hitherto wholly undiscovered, and must have remained forever undiscovered but for this combined triumph of time, telescope, and camera.

As photography joined to the power of the telescope and in other ways has advanced the science of astronomy and enlarged its area of knowledge, so also in many similar, and in many different ways, may and already has photography joined to photo-engraving advanced the breeder's interest through the agricultural press and otherwise.

I might speak of the way in which it has aided the investigator by producing exact photographs of the objects that he wants to minutely observe and study at his leisure. I will not speak of that to-night, but rather of how it has advanced the breeder's interests through the agricultural press. As I have already said, it imprints upon the inner vision of its tens of thousands of readers the correct concepts of the types and breeds and individual animals, thereby creating a longing for their possession. For example, nearly every week Joseph E. Wing and others, in the Breeders' Gazette, Alva Agee and others in the National Stockman, and John F. Cunningham and others in the Ohio Farmer, and many others in many other good agricultural papers present exact photo-engravings of from two to ten or more ideal and yet actual horses, cattle, sheep, swine, fowls, and the like, often with the homes of the animals and of their owners, and with educational notes as to the methods used by the owners in the production of such perfect animals. The educational and appetizing influence is beyond all computation in its healthy influence in increasing profitable sales, and unless we can have profit in breeding, breeding must fail. Second, aside from this indirect and free advertising is the direct and paid advertising. The old and hideous wood-cuts of animals that used to occupy a half inch by one inch in many advertisements, mere cubes or parallelopipedons with four short vertical pegs for legs, and a small longitudinal projection for neck and head. Such black blotches on the page could but repel. But if you put at the head of your advertisement a clear and correct half-tone likeness of the head of your herd, for example, *it will invite sales.* Let me say, both from experience and observation, that results in advertising are in proportion to two things chiefly aside from the natural demand for the product: (1) The amount of space used, and (2) The striking character of the matter inserted—artistic, amusing, or remarkable in some other way. Beauty and humor combined to make an advertisement attractive and telling are illustrated in the advertisements of some of our popular brands of soap, breakfast foods, and the like. The humor of some advertisements makes you want to buy the articles advertised.

Pardon me if I give some of my own experiences in this matter of advertising, for if the agricultural press is going to help the breeder, and conversely the breeders the press, it must be through the advertising column. I am myself not altogether an editor, but a farmer as

well, and on my little farm of 116 acres I raise a great many carloads sometimes each year of things to be sold, and to be sold to consumers by advertising. This year I had 8000 bushels of apples, and sold every one of them direct to consumers by advertising, and no more telling advertisement did I ever have than the photo-engraving of one tree with two men standing by it, the limbs drooping to the very ground and resting upon it, borne down by splendid apples. That cut at the head of the advertisement sold the apples.

Take another example: One year I had something like 2000 or 3000 bushels of seed wheat to sell. I do not cross wheat myself to produce new varieties, but I take it after it has been hybridized or crossed and has established under tests certain averages which are of record as winning averages, and then I raise it in a large way and sell it at a fair price. Well, one year I had, as I say, perhaps 2000 bushels that I wanted to sell at a fair price. I simply got a man with a camera, and I stood in that tall wheat, which yielded 43 bushels to the acre that year; I stood just a foot or so inside of it, and the density of the wheat stalks cut off my entire body up above my nose, leaving the eyes showing above; and with that photograph which cost $10 at least for each insertion—and was worth $100 for each insertion—and simply the words, "43 Bushels per Acre," and the price, the wheat went. That year, I remember, after using that advertisement, I had to buy 2000 bushels of my neighbors who were growing wheat of the same average yield that I knew to be pure and almost equally good, and I had to return more than $3000 of money as I could not fill the orders after buying all that I did. I thought it was better to do that than to go to Canada.

Or, take another example: One year I had a new variety of potatoes to sell which I thought was a winner. I had some 3000 bushels. I washed some of the potatoes and placed them upon a beautiful background, took a photograph and used it in selling the potatoes. I sold 3000 bushels of them at about $1.00 a bushel, when the other potatoes of a common variety which I had buried in order to get a better price in the spring were finally worth 10 cents a bushel. The picture did the business. Now, I advertised in our own paper, in which I am not a stockholder, and our firm received several "kicks," as we call them, from our advertisers who complained that there was no use in advertising as long as Mr. Chamberlain advertised, because he was the editor. I think that hardly one in fifty of the men who ordered of me knew that I was the editor, or happened to think of it; but the difference was that I bought perhaps $50 worth of advertising that year while those men who did the kicking paid from $2 to $4 each. The results of advertising are largely in proportion to the space occupied, the prominence of the treatment, and the striking character of the advertisement. I occupied ten times as much space, and had more striking matter.

Now in this very thing lies a lesson to the breeders. A fine half-

tone cut of the head of the herd, or of particular animals to be sold, will pay, and pay many fold.

Another thing I have noticed that will be a help and perhaps an inducement to some breeders who may not have noticed the same thing: I would rather take 10 inches in one issue, or 10 half inches, than 1 inch or 1½ inches in ten issues. You have got to attract the attention by something remarkable in some way, as, for instance, articles written by the breeders themselves. The benefits here are reciprocal. The benefit in one way is that the readers of the paper become familiar with the name. When they see such a one's advertisement they say, "Why, that is the man who wrote that remarkable article on his methods of breeding, and told how he did it; and I want to know what his animals are like."

Another way in which the press does a great work for the breeders and growers is by popularizing the bulletins of our National Department and our State experiment stations. It is true that men will read what they pay for, and that they will not read very much that they do not pay for. The agricultural press takes complicated and abstruse bulletins filled with statistics, and boils them down, giving, as you might say, the maple syrup of the thing instead of the unboiled sap. It is the cream instead of the skimmed milk of the Bulletins, given, too, in a form so condensed that it can be easily assimilated. It is boiled down and condensed so that the results can be readily learned and understood, and then it is all made more striking by pictures, and is circulated by hundreds and thousands of copies, whereas the station itself can have spread abroad but a very few, comparatively speaking. This work benefits the stations as well as the papers, the breeders as well as the consumers or farmers who buy the products. Without the patronage of the advertisers, it would be impossible to furnish these papers—or, for that matter, any other papers—at the price; for example, the price of the Ohio Farmer—$1.50 for three years—would not pay for the white paper on which it is printed, and the postage.

Chairman WARD. Are there any remarks? If not, we will proceed with the next number, the report of the Committee on Breeding for Dairy Production, which will be presented by Mr. W. H. Sherffius, of Lexington, Ky.

Mr. Sherffius explained that the paper which he would read was entitled, "Breeding Dairy Cattle," and its author was Mr. M. A. Scovell, who was absent on account of sickness in his family and had requested Mr. Sherffius to read the same.

BREEDING DAIRY CATTLE.

By Director M. A. SCOVELL, *Lexington, Ky.*

The subject of breeding dairy cattle is so comprehensive that it would be impossible to confine it to the time assigned me, even though it only be touched upon in a general way. I do not suppose, however, that it was intended that this paper should cover the whole field, and, therefore, it is my purpose to confine my remarks to a single subject.

The object of breeding is to make better, to improve. The objects to be obtained in breeding dairy cows are to increase the flow of milk; to increase its richness, especially in butter fat; to improve the form of the animal, and to increase vigor of constitution.

The first requisite is to obtain cows that will transmit desirable qualities with reasonable certainty. Have we such cows? That is, have we cows that have been bred for generation after generation for milk and butter production? We know that we have a number of breeds of such cows. For instance, the Jersey has been bred for a long period, first for butter production or for richness of milk, then for beauty of form, and finally for the production of milk.

In looking over the field for the purpose of studying breeding in the dairy line, perhaps no breed can be found with a more unique history. The investigator who is planning breeding experiments in wheat, for instance, for flour production, would consider himself fortunate indeed if he could find some seed to start with that had been grown on some island, isolated from all other varieties for 200 years, and which had received during that time careful culture to perpetuate its qualities, and not only the careful attention of individual farmers, but the fostering care of an organized agricultural society which had given prizes each year for the best heads of wheat, and which had retained these specimens for seed wheat from year to year, and had recommended and urged the farmers to increase its yield as well as its quality. Such a wheat would be an ideal wheat for breeding experiments for its further development. So it is with the Jersey. She has been bred on an island free from contamination of other breeds for nearly 200 years. The origin of the Jersey is conjectural. The earliest writers claim that the cattle on the Island were superior to those of Normandy and Brittany. As early as 1734, we find Philip Falle saying, "The cattle on this Island are superior to the French." In 1812, Thomas Quayle claims an advantage over any other breed in the quantity and quality of cream produced. It is interesting to note also that these same writers state that in summer 9 quarts and in winter 7 quarts of milk produced a pound of butter, showing the richness of the milk at that time. Another writer in the first part of the last century, gives the yield of milk about 3 gallons per day and the butter yield from 220 to 230 pounds per year per cow. Another claims 7 pounds of butter per week and 10 pounds of milk per day as a good average.

The Jersey at that time was described as an ugly, ill-formed animal with flat sides, cat-hammed, narrow and high hips with hollow back, yet possessing a lively eye, round barrel and deer-like limbs. The superiority of the Jersey over the cattle of the adjacent mainland of France was attributed to the circumstance of the farmers having constantly attended to raising stock from cows of the best and richest milking qualities.

An organized attempt was made to give fixed beauty of form to the Jersey about 1835, at which time a scale of points was adopted and judges were selected to give prizes to the best cows. The prize winners could not be sold from the Island for a year after receiving a prize, and a prize-winning heifer must drop a calf on the Island before being sold.

At an early period steps were taken to keep the breed pure by preventing outside cattle coming into the Island; in 1763 an act was passed which has since been rigidly enforced and supplemented by the further acts of 1769, 1826, 1864, and 1878, prohibiting the landing of cattle on the Island. But even before the enactment of laws, the purity of the cattle was maintained by the persistency with which the Jerseymen clung to his own breed, and every effort to introduce other cattle, even from England, was invariably rendered futile by the inhabitants.

The Agricultural Society of Jersey organized in 1833 has been one of the chief means of improving the general character of the breed on the island and of developing its valuable dairy qualities. In 1836 the society recommended that one superior bull be kept in each parish, and that encouragement be given to keep first-rate heifers in the Island. About 1838, it enacted two new rules: One to the effect that any person withholding the services of a prize bull from the public should forfeit the premium; the other, that all heifers, having premiums adjudged to them, should be kept on the Island until they shall have dropped their first calves.

In 1853, this society reports: "That the only means of keeping up the reputation, and as a natural means the pecuniary value of our native breed, are to prevent its deterioration, to eradicate its defects, and to perpetuate and increase its excellencies. Such results can only be obtained by selecting the finest and most perfect for reproduction, resolutely rejecting from the breeding stock every animal in which defects are to be found, like produces like, being a maxim which every breeder must ever keep in mind." In 1862, it reports, "that to a considerable extent the business of our Society is limited to the improvement of our insular race of cattle, which in itself is of the highest importance. We, therefore, wish to impress an observation on those who study the improvement of their stock. Beauty and symmetry alone cannot ever be the acme of perfection. The latter can only be obtained when goodness and beauty are equally combined. It is an established fact that the renown which the Jersey cow enjoys is

attributable to the peculiar richness of its milk as well as to its docility of temper and neatness of form. Now as this richness is not so marked in some specimens as it is in others, it becomes advisable to make such selection in breeding as will ensure further amelioration in this most essential and highly important point."

Until 1865, there appears to have been little attention paid to the quantity of milk which the Jersey gave, but in that year a committee of the Agricultural Society of Jersey urged that the Jersey breeder should pay greater attention to the milk-producing qualities of the cow, and that every cow with the least tendency to deficiency in quantity of milk should be weeded out. It will be seen, therefore, that the Jersey has been bred for quantity of milk for only about forty years.

From its organization to the present time, it will be seen that the Agricultural Society of Jersey has been actively engaged in the improvement of the Jersey. Under its auspices, there are parish shows held each year besides three Island shows, namely, the spring show for bulls; the May show for heifers, and the summer show for animals of both sexes. There is also a butter competition test. Prize bulls must be kept on the Island for one year after receiving a prize and heifers until they have had their first calves, and no bull can win a prize unless his dam receives a commendation.

In America or in England, or perhaps anywhere else in the world, an animal may be registered in the Herd Book as soon as born if its sire and dam are registered or are capable of being registered. On the Island of Jersey, however, inspection is made a conditional precedent to registration. The following are necessary conditions to registration:

1. Every animal must be inspected by competent judges and if it is considered fit, it obtains a qualification, namely, commended or highly commended.
2. Every bull submitted for qualification must be accompanied by his dam, in order that the merits of the latter may be taken into consideration in awarding a commendation to the former.
3. No heifer, although she may be descended from registered parents, can be entered into the Herd Book until she has had a calf, and if at the time of her examination she does not appear worthy, she receives no commendation and cannot be pedigreed.

It will be seen, therefore, that by the method of registration on the Island of Jersey, not only the pedigree can be traced but it can be ascertained whether the dams and sires for generations back have been commended or highly commended by the commissioned judges. Those commended are shown in the pedigree by the letter *C*, and those highly commended by the letters *H C*.

I have endeavored to show by this historical sketch, that the Jersey owes whatever dairy qualities it possesses to persistent breeding to perpetuate and accentuate distinctive qualities, and to the exclusion of all other cattle from the Island.

If I were given the task of still further improving the Jersey, I

would breed on the lines of milk production and of constitutional vigor. To this end, I would select cows which are large milkers, of vigorous constitution, and of fine dairy form. I would select only after studying very thoroughly their pedigrees for generations back. I should want to trace each one, without a shadow of a doubt, back to the Island of Jersey, or select Island-bred cows, and I should still further desire to trace the pedigree on the Island ten or more generations back, with the hope of getting only those that had received the qualification of "commended" or "highly commended" by the commissioned judges on the Island of Jersey. The bull to head the herd, I should select with still greater care. Not only would I trace his pedigree the same as that of the cows, but if possible, I should want his dam to have had daughters that were renowned for their milk and butter qualities, and so with his dam's dam. The daughters of his sire should be either "commended" or "highly commended" and so with their sires and dams for generations back. With such a herd, I should expect within a few years to see marked improvement in the amount of milk and butter produced. If "like produces like," certainly those cows that have been bred for 200 years for butter production should be very susceptible to higher attainments, and even good results should be expected from forty years' breeding for increase in the flow of milk.

Comparing results of the Columbian Dairy Test with those of the Cow Demonstration at St. Louis, we find that Jersey cows averaged at the Columbian ninety-day test, 32.6 pounds of milk per day. Eleven years afterwards at the St. Louis demonstration, the same number of cows selected in like manner and under like conditions, averaged 41.5 pounds of milk per day, showing an increase in eleven years of an average of nearly 10 pounds of milk per day. The increase in butter fat was in like proportion.

If I were given the problem to improve the Holstein-Friesian as a dairy cow, I would undertake to increase the percentage of butter fat, and I would select my herd in the manner, so far as possible, as that described for the Jersey, care being taken in every instance to select those known to give rich milk. And so with other breeds. In making an experiment, I would endeavor to improve those qualities which are most lacking in the breed, at the same time ever keeping in view the characteristics of the breed and its predominant qualities.

The problem is to improve the qualities already obtained, and I believe experiments carried out on the lines suggested would be of vast importance to the people of this country.

After the Angelus Ladies' Quartette had, by request, sung "Comin' thro' the rye," the Association adjourned until 10 o'clock a. m., January 18, 1907.

FRIDAY FORENOON, JANUARY 18—GENERAL SESSION.

The Association met with the Ohio agricultural societies in University Chapel at 10 o'clock, with Hon. A. P. Grout in the Chair. He announced that the first number on the program would be the report of the Committee on Animal Hybridizing, by Prof. W. J. Spillman, of the United States Department of Agriculture.

REPORT OF COMMITTEE ON ANIMAL HYBRIDIZING.

By Prof. W. J. SPILLMAN, *U. S. Department of Agriculture, Washington, D. C.*

The principal lines of work undertaken by this committee are as follows:

(1) The collection of known facts recorded in the literature of the subject relating to hybridization of our domesticated animals. Prof. F. B. Mumford, Columbia, Mo., has been appointed a sub-committee in charge of this work.

(2) Securing records of results of crossing by breeders in this country with a view to determining the laws governing the transmission of breed and other characters. With this end in view, the committee has prepared a set of breeding records which have already been placed in the hands of a number of breeders who are crossing domesticated breeds.

Cross breeding is going on all over the United States. The results, if accurately recorded, would enable us to unravel the inheritance of a large number of characters of greater or less importance. The first cross between two breeds shows which characters are dominant and which recessive, and which character pairs produce mosaics. By breeding the first cross together, and also by breeding the first cross to each of the parent forms, the unit characters are revealed. It is well known that hybrids are, generally speaking, much more vigorous than purebreds. If we understood the inheritance of all strictly breed characters we should have the possibility of the introduction of blood from other breeds without disturbing breed characters, thus securing the tremendous advantage which comes from cross breeding, while at the same time maintaining a breed type.

A number of breeders, whose work is known to the committee, have already secured highly important results. Mr. Q. I. Simpson, of Palmer, Ill., has made numerous crosses between the wild boar of Europe, Tamworths, Yorkshires, Poland Chinas, Duroc-Jerseys, and Chester White swine. These crosses have enabled us to determine a number of unit characters and their behavior in inheritance. Mr. Mossom Boyd, of Bobcaygeon, Canada, is crossing Buffaloes with Hereford and Aberdeen-Angus cattle. He has also crossed the Aberdeen-

Angus and the Hereford with a view to introducing into the Hereford breed the polled character of the Aberdeen-Angus, in which he has been highly successful. The Polled Herefords have proven to be of great vigor, and are highly popular with his patrons on the western ranges. Prof. W. J. Kennedy, of Ames, Iowa, is crossing Galloways with white Shorthorns. The first cross is a blue roan, and Prof. Kennedy has eleven of these animals. He has arranged to breed them to the two parent types, as well as to each other. This will render it possible to work out the laws of inheritance of a number of important breed characters. Some results are already at hand and are of great interest.

The record blanks prepared by this committee have been placed in the hands of these breeders and a number of others. The blanks are of two forms, one for individual animals and the other to be used in cases of crosses between breeds of hogs for litters. They are as follows:

BREEDING RECORD OF INDIVIDUAL ANIMAL.

Herd of..... *P. O*..... ..... *Herd No*.....
Name..... *Sire*..... ..... *Dam*... .....
Reg. No..... *Reg. No*..... *Reg. No*.....
Date of Birth..... *Herd No*..... *Herd No* .....
Description..... .....
.....

Date.	Animal Bred to—		Date of Delivery.	No.		Herd Numbers of Young.	Remarks.
	Name.	Herd No.		M.	F.		
.....	.....	.....	.....	....	....	.....	.....
.....	.....	.....	.....	....	....	....	.....

LITTER RECORD. *Herd of*..... *P. O*..... ..... *Litter No*.....
Date of Birth..... *Sire*..... ..... *Dam*.....
No. pigs born..... *Reg. No*..... ..... *Reg. No*.....
No. pigs raised..... *Herd No* ..... *Herd No*.....
Herd numbers of pigs..... ....

DESCRIPTION OF INDIVIDUALS.

1 ....
2 ....
3..... ....

The work of collecting data of this kind from breeders has only just begun, but has already enabled your committee to work out a number of characters. Data thus far collected is decidedly fragmentary and cannot be regarded as scientifically accurate. Most of it relates to colors, the most obvious breed characters. With the system of records we have instituted we hope to get data on characters other than color.

These records may easily serve as a basis for registration of hybrid animals. Your committee would recommend that it be authorized to issue certificates of registration of hybrids on the basis of the records secured under the usual conditions for securing accuracy of data.

(3) Improvements of breeds by crossing. The study of the improvement of breeds of domestic animals by cross breeding involves a number of important considerations. The most important of all is the effect of the introduction of new blood on constitutional vigor. This committee is giving special attention to this phase of the question. Closely related thereto is the effect of inbreeding and line-breeding in reducing constitutional vigor.

In established breeds in this country it has long since ceased to be the custom to introduce new blood. While we are not ready to propose the introduction of new blood into established breeds in this country, there is no question that superior breeds can be produced in this manner. In this connection it is a matter of importance that we should learn the effect on breed characters of the introduction of new blood from different sources. As soon as we have worked out the inheritance of these characters we shall then know how to avoid serious difficulties of this kind. Already a good deal is known in this direction. For instance, we have learned how to introduce the polled character into horned breeds without otherwise visibly affecting the breeds, except to increase constitutional vigor by the out-cross. Definite rules of procedure in dehorning cattle by cross breeding have been formulated and were published in Volume II of the report of this Association.

Many years ago a few Brahmin cattle were introduced into Southern Texas. The crosses between these cattle and American cattle proved to be immune against the southern cattle tick. These crosses have increased in number, and are at the present time an important factor on the cattle ranges of Southern Texas. Calves with sufficient Brahmin blood to be immune from injury by ticks grow much more rapidly, and at weaning time are worth, on the average, 50 per cent more than other calves. There has been no opportunity to study the inheritance of immunity or other characters in this cross, but sufficient is known to justify the recommendation that other cattle of this kind should be imported.

Another character which could be introduced into some of our breeds of hogs with great advantage is prolificacy. There has been no opportunity to study the inheritance of this character. From what is known concerning other characters there seems to be little doubt that it could be introduced without materially disturbing any other breed character.

Another important result to be attained by knowledge of inheritance of various characters is the elimination of undesirable characters from established breeds. Methods are already worked out for doing this in some cases. A few characters of this kind may be mentioned. In the Aberdeen-Angus there is occasionally produced a red animal; also occasionally one with horns. These characters have been so nearly eliminated that they are of little importance at the present time, but

it is practically established that, whenever these characters outcrop in this breed, both of the parents carry the characters, and neither of them should be used again for breeding purposes.

Horns appear occasionally in practically all polled breeds. When they do appear both parents contain this character in a hidden form, and neither of them should be used for further breeding.

Black sheep appear in flocks in exactly the same manner as horns do in polled breeds, and for the same reason. If it is desired to eliminate them entirely, both parents of a black lamb must be eliminated.

Mottled faces occasionally occur in Herefords, and less often colored faces. The same thing is true in this case as in the two cases just mentioned.

Some Chester White swine have black color hidden in them. This usually gives no trouble, but it quite frequently causes black skin, and occasionally black spots of hair. This character has not yet been studied sufficiently to ascertain the best method of eradicating it. Red breeds of swine occasionally contain black in more or less suppressed condition. The elimination of this black is not yet understood.

Hampshire swine are black with white belts. This breed has recently attracted attention and is working its way into popular favor. At the present time about 10 per cent of the pigs lack the white belt. The reason for this has recently been worked out by a member of this committee, and the manner of eliminating this undesirable character is now understood.

It is an old saying amongst breeders that no new breed was ever formed from a cross between two breeds. There is no scientific basis for this saying, and there is no question that several distinct and fixed new breeds can easily be produced by crossing two breeds. It is true that the type which appears in the first cross between breeds, when this type differs from both of the breeds, can usually not be fixed; but by breeding the cross-breds together a number of new fixed types are obtained.

A few of the unit characters which have been worked out in domestic breeds may be mentioned. The poll character and horns in cattle form a Mendelian character pair, the poll character being dominant, a portion of the hybrids having imperfect horns, or scurs.

There are two color characters in Tamworth swine, namely, light red and dark red. They act as a character pair; the light being dominant. The light red of Tamworth, when crost with Chester, makes a red roan; the dark red gives white in the first generation.

The white of the Yorkshire, Chester White, Berkshire, and Poland China seems to be allomorphic with red in Tamworths and Duroc Jerseys, though this is not fully established. Yorkshire White is dominant over Poland China and Berkshire Black. These two characters, however, are independent and do not form a Mendelian character pair. The black of the Aberdeen-Angus is dominant over Hereford red, and these characters appear to form a pair. The white face of the Here-

ford is dominant over the colored face of the Angus. These two last points are deduced from the work of Mr. Mossom Boyd, a member of this committee, while the facts above stated concerning the behavior of color in swine are deduced from the work of Mr. Q. I. Simpson, another member of the committee.

Dr. C. B. Davenport has recently shown that the black character in sheep is recessive to white, and that the two behave as a character pair.

Both black and white in the Hampshire are dominant over red in Durocs. Black and red in swine seem to be independent characters, while white and red seem to form a character pair.

The belt of Hampshire swine appears to be due to the presence of a compound character of two factors which governs the distribution of color in this breed. These two characters are independent, and each is dominant over its opposite, namely, the absence of the character. Both of these factors which determine the distribution of color are transmitted independently of the colors themselves. It has already been stated that about 10 per cent of this breed do not have the belt. With the knowledge we now possess concerning the inheritance of the factors causing the belt, we can rapidly reduce the number of swine in which the belt fails to appear.

The black of the Poland China and Berkshire, when crossed with the red of the Tamworth or Duroc, produces a black and red spotted hog. In other words, this combination produces a mosaic of the two characters. Black and red in swine are not allomorphic, and may, therefore, be transmitted together.

(4) A fourth subject to which this committee is devoting attention is that of the fertility of hybrids, as well as aberrant hybrid forms. Dr. Guyer, of the University of Cincinnati, has shown that lack of fertility in certain hybrid pigeons is due to the inability of the chromosomes to pass through the synaptic stage. Your committee is able to report on the authority of Van Buren & Tufts, Mitchell, Ga., that the cross between Pekin and Muscovy ducks is sterile. This cross should furnish material for cytological study. These gentlemen state that the cross is larger than either breed, that the males and females are uniformly colored, but the two sexes are not of the same color.

Your committee would call attention to the difficulty experienced by breeders who desire to secure domesticated animals from Europe for crossing with American breeds because of importation restrictions. It would seem that these difficulties could be removed by proper action of Government officials, especially by maintaining quarantine stations on this side of the water where imported animals could be held until they were known to be free from disease.

It is hoped that the present interest in breeding will enlist the efforts of wealthy men who maintain farms and breeding establishments for pleasure. This committee would take pleasure in assisting men who are in position to do work of this kind in suggesting desirable crosses.

During the past year your committee has communicated with the

various zoological parks in this country where animals are kept with a view to ascertaining what animals might be available for crossing with domesticated breeds. Appended to this report are lists of animals in the zoological garden at Philadelphia and in the National Zoological Park at Washington, D. C. Attention is called to the difficulty of utilizing these animals in breeding experiments. Most of these animals have been secured at great expense and can hardly be loaned. The park authorities usually do not have facilities for keeping ordinary domestic animals with which the animals under their care could be crossed. Generally speaking, however, the superintendents of these parks, particularly Superintendent Baker of the park at Washington City, express interest in the work, and offer to cooperate as far as possible.

List of Animals at the National Zoological Park, Washington, D. C.

Swine.—Wild boar, male and female; and collared peccary, male and female.

Cattle.—American bison, male and female; zebu, male and female; yak, male and female; Philippine buffalo (*Buffelus bubalus*), male, castrated; and anoa, male.

Sheep.—Mouflon, female; Barbary sheep, male and female; blue sheep (*Ovis nahoor*), male.

Horse.—Grevy's zebra, male.

List of Animals at the Philadelphia Zoological Garden.

Chapman's Zebra (*Equus burchelli*).
Persian Wild Ass (*E. onaga*).
Wild Boar (*Sus scrofa*).
Red River Hog (*Potamochoerus porcus*).
Wart Hog (*Phacochoerus aethiopicus*).
American Bison (*B. bison*).
Barbary Sheep (*Ovis tragelaphus*).
Mouflon (*Ovis musimon*).
Himalayan Thar (*Hemitragus jemlaicus*).
Doreus Goat (*Capra doreus*).
White-Lipped Peccary (*Dicotyles labiatus*).
Zebu (*Bos indicus*).

There is probably not a great deal to be gained in crosses between these animals and our domesticated breeds. It is, however, not possible to say in advance what crosses would be of value, and important results might follow where least expected.

DISCUSSION.

Chairman GROUT. Before we proceed to the next topic, there may be some questions. A question that occurs to me as a practical farmer is this: What good practical thing can be accomplished by this breeding?

Mr. SPILLMAN. I am not sure that there will be any practical results come from it, and yet it seems to me that a knowledge of the laws of inheritance cannot fail ultimately to do some good. I will specify one instance; I found a few men who were trying to breed horns off of Hereford cattle. They had a few polled Hereford cattle.

I got in conversation with one of these gentlemen and found that he had been crossing those Herefords with Polled Durhams. The Hereford white face is a dominant character. By selecting for four or five generations he had an animal which was apparently a pure Hereford except that it was polled. Another man had searched through the whole breed of Hereford cattle and had found fourteen polled animals in the registration book of the Hereford breed. He had bought some of them and gotten them together, so that he had a few polled animals that were registered Herefords. This man went to breeding, and selling the stock. After a while they began to attract some attention, and finally two associations were organized, so that we have now in this country two polled Hereford breeding associations. One is called the Polled Hereford Cattle Club, and the other the Polled Hereford Breeders' Association, I think. Now these men were having a good deal of difficulty in keeping their animals from pairing with other cattle. By the merest accident my attention was called to their work, and I went to study the laws of inheritance governing the transmission of the polled character. It was only a small piece of work to discover that the polled character and the horned character form a Mendelian character pair. We all know how a Mendelian character pair behaves, and we know what the progeny will be. I undertook then to outline the rules of procedure for those breeders for the elimination of the horns from their horned Herefords. I happen to know that at least a dozen of the leading breders have those rules pinned up in their stables, and that they are using them. Only just a day or two ago before I left home I had a letter from a man who had paid $500 for a polled calf that I had assured him was a pure polled and not a hybrid polled. He says now that he has had 27 calves from him from horned cows, every one of which is polled. He thinks that this was cheap, although it cost him $500. That is one instance of the practical application of scientific knowledge in accomplishing a definite purpose in breeding. (Applause.)

Dr. CHAMBERLAIN. Will the gentleman, for the benefit of the agricultural press, please state in the briefest form and in practical language the Mendelian law so often referred to and so well understood by scientific men, so that we can make it plain to our readers just what it is?

Mr. SPILLMAN. You men do not know what you are stirring up when you get me started on that subject.

Dr. CHAMBERLAIN. I said, in the briefest possible language.

Mr. SPILLMAN. The difficulty is in that word "brief." Here is an animal which has horns, which is known, we will say, to be pure horned; and here is another which is polled and known to be pure polled. This polled animal is incapable of transmitting the horned character, and the horned animal is incapable of transmitting the polled character. We cross those two, and the progeny inherits the polled character from this side, and it inherits the horned character from the other side.

It happens in this case that this progeny that has both characters present will be polled in appearance. Of course we may have about 5 to 10 per cent of these crossed animals that have imperfect horns, scurs as they are called, but the remainder look like pure polled. Now the following is the Mendelian law stated in one form, though there are many ways in which I could state it: This hybrid will transmit the polled character to half of its offspring, and the horned character to the other half. Now that is the Mendelian law. It is all built up from this fact, that when two animals or plants differ with respect to one character, which behaves as a Mendelian unit character, if we cross them we get an individual which will usually show one of the characters but will possess both. When that individual produces progeny, it will transmit one of the characters to one-half of its progeny, and the other character to the other half.

But I have gone a little too far already; I have jumped a step. It will not in all cases transmit this character to half of its progeny exactly. That will be true of cattle, but not true of corn, for instance. It will produce two kinds of reproductive cells. One kind will have one character in it, and the other kind will have the other character in it. That is the actual fact of the case.

RESULTS OF HILL SELECTION OF SEED POTATOES.

By C. W. WAID, *Ohio Experiment Station, Wooster, Ohio.*

In the spring of 1903 a set of experiments was begun at the Ohio Experiment Station for the purpose of securing data which would throw more light on the question of the effect of hill selection of seed potatoes upon the resulting product.

These experiments were conducted along two distinct lines. In one case, the seed was selected from high-yielding and low-yielding hills, and in the other, from hills the plants of which were especially vigorous or had the ability to resist disease.

SEED SELECTED FROM HIGH-YIELDING AND FROM LOW-YIELDING HILLS.

In 1903 200 hills of Carman No. 3 were planted, from which the selections were to be made. At digging time the potatoes from each of 100 hills were weighed and counted; 40 of the heaviest yielding hills were scored on the basis of uniform size, regular form, freedom from disease, and yield. The 10 hills which scored the highest were sacked separately and stored for another year. The 20 lowest yielding hills were also sacked separately and stored. The other 100 hills were dug, the potatoes were thrown together and enough seed was selected to plant 100 hills. In making the selection, uniform-sized tubers were chosen but with no reference to individual hills. In the spring of 1904, 10 hills were planted from each of the 10 hills which scored the highest the previous season, making in all 100 hills. Five hills were

planted from each of the 20 low-yielding hills, or 100 in all. Finally 100 hills were planted from the seed which had been selected without reference to individual hills to serve as a check. They were planted in a row between the rows in which the other selections were planted. No duplicates were planted in 1904. At digging time the tubers from each hill grown from the high-yielding and low-yielding hills were weighed and counted, and were then sacked, labeled, and stored. The product of the check row was also weighed, counted, and stored.

In 1905, 100 hills were planted from the product of the high-scoring hills. The seed for these hills was selected in the following manner: Hill No. 1 was planted from seed taken from hill No. 1 of the previous year; hill No. 2 from hill No. 2 of the previous year, etc., the seed for each hill being taken from the hill which occupied the same place in the test the year previous.

TABLE 1.—*Yields (by weight) from seed selected from high-yielding hills.*

[Variety, Carman No. 3.]

Hill No.	Yield of selected hills, 1903.	Yield of groups of 10 hills each grown from original hills or from their products.			
		Total for 10-hill group, 1904.	Total for corresponding 10-hill group, 1905 *	Total for corresponding 10-hill group, 1906.*	Average 10-hill groups, 1904–5–6.
	Lbs. Oz.	*Lbs. Oz.*	*Lbs. Oz.*	*Lbs. Oz.*	*Lbs. Oz.*
1.....	2 8.0	13 12.0	16 8.0	9 4.8	13 1.3
2.....	2 13.0	15 4.5	15 9.0	9 0.5	13 4.7
3.....	2 10.5	12 1.5	18 3.0	10 14.0	13 11.5
4.....	2 2.5	11 15.0	17 11.0	11 1.8	13 9.3
5.....	2 3.0	12 8.5	16 9.0	11 10.3	13 9.3
6.....	2 1.0	10 9.5	15 0.0	14 3.3	13 4.3
7.....	3 1.0	13 8.5	18 7.0	15 11.0	15 14.2
8.....	2 7.0	10 11.5	18 1.0	13 4.3	14 0.3
9.....	2 1.5	12 14.5	19 10.0	11 6.0	14 10.2
10.....	1 14.0	12 0.5	18 8.0	10 5.0	13 9.8
Totals.	.....	125 6.0	173 13.0	116 13.0	.....

* Average yield of original and duplicate tests.

The yield of the product of the low-yielding hills in 1904 was so variable that it was thought advisable to make a second selection for the 1905 test. Hence 5 of the lowest and 5 of the highest yielding groups of hills which were grown from the 20 low-yielding hills as selected in 1903 were selected, and 10 hills were planted from each group of hills. The check row was planted as before. All of these plantings made in 1905 were in duplicate.

At digging time the potatoes from each hill, except those in the check row, were weighed, counted, sacked, and stored. The product of the check row was weighed, counted, and stored.

The test was continued in 1906 exactly as carried on in 1905, duplications and all.

The results of these tests extending over a period of four years, counting the year in which they were begun, are given on the charts. The figures given are actual yields of single hills, groups of 5 or 10

hills, or of 100 hills. The soil on which these tests were made was not in a condition to produce large yields, but, as it was uniform, the comparisons are as reliable as they would have been if the test had been made on more fertile soil. When duplications were made the figures given are the average for the original and duplicate tests.

By referring to the last column on Table 1, which gives the average yield for each group of 10 hills for the years 1904, 1905, and 1906, it will be seen that 7 of the group gave an average yield of between 13 and 14 pounds per group, 2 an average of between 14 and 15 pounds, and one an average of 15.9 pounds. It should be noted that none of the averages is low but that only one is sufficiently high to indicate a superior producing power. It should also be noted that the group which gave the highest average yield (No. 7) was the product of the highest yielding hill selected in 1903.

TABLE 2.—*Yields (number of tubers) from seed selected from high-yielding hills.*

[Variety, Carman No. 3.]

Hill No.	Number of tubers in selected hills, 1903.	Number of tubers yielded by groups of 10 hills each grown from original hills or from their products.			
		Total for 10-hill group, 1904.	Total for corresponding 10-hill group, 1905.*	Total for corresponding 10-hill group, 1906.*	Average for 10-hill groups, 1904-5-6.
1.....	6	85	84	53	74
2.....	6	85	83	56	75
3.....	10	84	99	70	84
4.....	6	71	84	65	73
5.....	5	68	77	68	71
6.....	7	81	76	93	83
7.....	11	94	96	79	90
8.....	10	73	81	66	73
9.....	7	67	95	63	75
10.....	7	73	90	63	75
Totals.	.....	781	865	676	.....

* Average number of tubers in original and duplicate tests.

Table 2 gives the number of tubers grown in the same set of hills shown in Table 1. Here, too, we see that hill No. 7 takes the lead. The number of tubers in the original hill was 11 and the average for the group of hills is 9. With the exception of hill No. 8 the average number of tubers for the groups is quite consistent with the number which grew in the original hills.

A comparison between the yield of the original hills and the groups of 5 grown from them, as given in Table 3, shows that many of the supposed low-yielding hills turned out to be comparatively high-yielding hills the second season. This shows that one season's test cannot be depended upon to show what productive ability or lack of it certain hills may possess. Environment always comes in for its share of influence.

Table 4 first gives the yields of the 10 groups of 5 hills each which

were selected from the product of the 20 low-yielding hills. The groups of hills grew in the row in 1905 and 1906 in the same order as given in the table. Nos. 1, 3, 5, 7, and 9 were low-yielding groups, and 2, 4, 6, 8, and 10, high-yielding groups. Following these are the yields of the groups of 10 hills each which were grown in 1905 and 1906 from the 10 groups of hills selected in 1904. The last columns show the average yield of the groups of hills for 1905 and 1906.

It will be noted that, while the variation in yield by weight in 1905 and 1906 is not as great as that shown in 1904, yet the lowest average yield of the high-yielding group—that of No. 2—is over 2 pounds heavier that the highest average yield of the low-yielding group—that

TABLE 3.—*Yields (by weight and by number of tubers) from seed selected from low-yielding hills.*

[Variety, Carman No. 3.]

Hill No.	Yield of selected hills, 1905.			Yield of groups of 5 hills each grown from seed of low-yielding hills, 1904.		
	Number of tubers.	Weight of all.		Number of tubers.	Weight of all.	
		Lbs.	*Oz.*		*Lbs.*	*Oz.*
1	2		3.5	25	4	0.0
2	3		4.0	14	1	4.8
3	1		6.0	25	3	14.5
4	2		6.5	17	2	14.5
5	3		8.0	16	1	12.0
6	3		9.5	26	3	12.5
7	7		10.0	19	2	7.5
8	3		10.5	20	2	4.0
9	5		11.5	26	4	2.0
10	3		12.5	29	4	8.5
11	4		13.0	30	5	0.5
12	4		13.5	31	4	6.5
13	5		13.5	32	5	2.5
14	4		14.0	39	5	3.5
15	6		14.5	36	4	13.5
16	5		15.5	31	6	8.5
17	3	1	0.0	25	1	5.0
18	4	1	0.0	42	7	11.5
19	6	1	0.0	43	6	13.5
20	8	1	0.0	40	6	6.5
Totals for 100 hills				568	84	7.8

of No. 7. The average yield for 1905 and 1906 of the five high-yielding groups together was 66 pounds, while the average yield of the low-yielding groups was 34 pounds, the former yield being practically twice the latter.

Table 4 also shows the number of tubers produced by each group. While the variation is not so great as in the case of yield, it is considerable. The 5 high-yielding groups together produced an average for the two years of 366 tubers and the 5 low-yielding an average of 227 tubers, a difference of over one-third.

Table 5 gives a summary of the results of that part of the experiment in which the seed was selected from low-yielding and high-yielding hills. The figures given for the high-yielding hills for 1904 show

the actual yield of 100 hills, and for 1905 and 1906 the average yield of the original and duplicate tests of 100 hills each, grown from the 10 high-scoring hills or their product. These figures were taken from Tables 1 and 2.

The figures given for the check show the actual yield of 100 hills grown in 1904 and the average yield of the original and duplicate tests, of 100 hills each, as grown in 1905 and 1906.

The figures given for the low-yielding hills for 1904 show the actual yield of 100 hills grown from the 20 low-yielding hills as selected in 1903 and shown in Table 3. For 1905 and 1906 the figures given are the sum of the yields of the 50 low-yielding hills grown in the

TABLE 4.—*Comparison of yields (by weight and number of tubers) from seed taken from the five highest yielding and the five lowest yielding groups shown in Table 3.*

Group No.*	Yield of 5-hill groups, 1904. (See table 3.)		Yield of groups of 10 hills each grown from seed from the 5-hill groups of 1904.							
			Total for 10-hill group, 1905.		Total for corresponding 10-hill group, 1906.		Average for 10-hill groups, 1905-6.			
	Number of tubers.	Weight of all.	Number of tubers.	Weight of all.	Number of tubers.	Weight of all.	Number of tubers.	Weight of all.		
		Lbs. Oz.		*Lbs. Oz.*		*Lbs. Oz.*		*Lbs. Oz.*		
1 (17)	25	1 5.0	28	2 10.5	29	3 12.0	28	3	2.3	
2 (18)	42	7 11.5	110	15 0.5	54	9 7.0	82	12	3.5	
3 (5)	16	1 12.0	56	6 11.0	36	5 1.0	46	5	14.0	
4 (19)	43	6 13.5	96	15 11.5	46	11 12.5	71	13	12.0	
5 (3)	20	2 4.0	50	8 1.5	35	6 1.0	43	7	1.3	
6 (16)	31	6 8.5	81	16 9.5	46	9 12.0	63	13	2.8	
7 (7)	19	2 7.5	68	11 5.5	49	8 13.0	58	10	1.3	
8 (20)	40	6 6.5	89	15 8.5	54	13 3.5	72	14	6.0	
9 (4)	17	2 14.5	71	9 0.5	33	7 4.0	52	8	2.3	
10 (14)	39	5 3.5	99	12 11.0	58	12 4.0	78	12	7.5	

*The numbers in parentheses are the numbers of originally selected low-yielding hills which appear in table 3. The new numbers, 1 to 10, have been assigned in such a way that the odd numbers—1, 3, 5, 7, 9—represent low-yielding groups and the even numbers 2, 4, 6, 8, 10—the highest yielding groups shown in table 3.

original test and the 50 low-yielding hills grown in the duplicate test of each season and which were grown from the 5 low-yielding groups of hills as selected in 1904 and their product and are shown in Table 4.

The average yield of the check for the three years was 110 pounds per 100 hills, and of the high-yielding hills, 138 pounds per 100 hills, a gain of one-fourth. The average yield of the low-yielding hills for the same period was 73 pounds per 100 hills, a loss of one-third.

The average number of potatoes produced by the check was 607 per 100 hills, and by the high-yielding hills 774 per 100 hills, a gain in number of over one-fourth. The low-yielding hills produced on an average 492 tubers per 100 hills, or a loss of about one-fifth.

One deduction which can safely be made from these results is that seed selected from high-yielding hills will produce a higher yield per

given area than seed taken from a pile or bin of potatoes for at least 3 years without further selection.

This taken together with the fact that the average yield of 1 group of 10 hills, which was grown from the highest-yielding hill of the 10 highest-scoring hills of the original selection, for a period of three years, was over 1 pound per year more than the average yield of any of the other 9 groups for the same period, will tend to lead us on to further efforts along the line of seed selection from individual hills of potatoes.

If it is the purpose to endeavor to increase the yield of a certain variety by this method of seed selection, it will not do to stop with the selection of the 10 highest-yielding hills out of 100, nor of 100 out of 1000. We must continue the selection from year to year and at the same time discard those which prove not worthy of further trial. We must keep in mind that we are working with individuals and

TABLE 5.—*Summary of results from use of seed potatoes from high-yielding hills and from low-yielding hills.*

[Variety, Carman No. 3.]

Source of seed.	Yield of 100 hills.				Number of tubers in 100 hills.			
	Total, 1904.	Total, 1905.	Total, 1906.	Average, 1904-5-6.	Total, 1904.	Total, 1905.	Total, 1906.	Average, 1904-5-6.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*				
High-yielding hills.	125	173	116	138	781	865	676	774
Check rows	115	136	79	110	718	630	479	607
Low-yielding hills..	84	75	61	73	566	546	364	492

that we should apply the same principles of selection, so far as possible, to the improvement of a variety of potatoes as the stock breeder does in building up a herd of cattle. It will require a large amount of tedious work and no doubt more work than most farmers will undertake, but the few who do take up this line of work and carry it on carefully should be able to secure abundant reward for their efforts.

The Ohio Plant Breeders' Association is preparing "rules of registry" for potatoes, and all persons in Ohio who contemplate taking up this line of work should become members of this association, not only that they may secure the assistance which it is able to give but also that it may be known that they are engaged in the work of plant improvement by the method of seed selection.

SEED SELECTION FOR BLIGHT RESISTANCE.

It is a known fact that some varieties of potatoes are more resistant to the early blight* than others. It has been observed that there is also a difference between hills of the same variety in this respect.

* The results here given refer only to the early blight.

This is more noticeable with some varieties than with others. In 1903 several hills of each of the following varieties were selected and saved for seed because of the apparent tendency of these hills to resist disease: Uncle Sam, Whiton's White Mammoth, Sir William, Livingston, Pat's Choice, and Quick Crop.

The following season, 1904, about 35 hills of each of these varieties (with the exception of Whiton's White Mammoth, of which there were 100 hills) were planted with the seed which had been selected for blight resistance and an equal number of hills of the same varieties were planted with seed which had not been so selected.

Without exception, the vines from the seed which had been taken with no reference to the blight began to break down with an attack of the disease much earlier than the vines of the same variety which had

TABLE 6.—*Results of hill selection of seed potatoes for blight resistance.*

[Variety, Whiton's White Mammoth.]

Seed.	Results in 1905.				Results in 1906.						
						Large tubers harvested.		Small tubers harvested.		Total yield.	
	Hills grown.	Large tubers harvested.	Small tubers harvested.	Total yield.	Hills grown.	Number.	Weight.	Number.	Weight.	Number.	Weight.
		Lbs.	*Lbs.*	*Lbs.*			*Lbs.*		*Lbs.*		*Lbs.*
Selected*	100	134	17	151	262	1048	312	222	13	1270	325
Not selected	100	96	25	121	262	950	220	318	19	1268	239
Gain from selection	.....	38	.....	30	.....	.....	92	.....	.....	.....	86
Percent of gain	.....	40	.....	25	.....	.....	42	.....	.....	.....	36

*Results are averages of original and duplicate tests.

been selected for blight resistance. By September 9, the difference was very marked and ten days later the vines from the seed which was not selected were nearly dead, while those from the selected seed were quite green.

The selected seed of the Whiton's White Mammoth was saved and two rows each 100 hills long were planted with it in 1905. One row of the same variety, but planted with seed which had not been selected for blight resistance, was planted between the other two for a check. The average yield of the two selected rows and the yield of the check row are given in Table 6. It will be noted that the gain in yield of the selected over the unselected was of large potatoes 40 per cent and of total yield, 25 per cent.

The test was continued in 1906 without further selection. A row of selected seed was planted 262 hills long and a row of unselected

seed of the same length. Of the former the yield of large tubers was 312 pounds, and the total yield 325 pounds; and of the latter the yield of large tubers was 220 pounds, and total yield, 239 pounds. The gain in large tubers was 42 per cent, and the total gain 36 per cent.

It should also be noted that while the total number of tubers was practically the same from both rows in the 1906 test, there were about 100 more large ones grown from the selected seed than from the seed which was not selected. This was probably owing to the longer period of growth of the former.

It should be understood that these results were secured with but one selection, that of 10 hills made in 1903. The product of these hills was carried over from one year to another without any further selection whatever. This certainly should be encouraging to the men whose potatoes are killed by the early blight before they have reached maturity.

Unlike the improvement of a variety by the selection of seed from the most productive hills, the work necessary to improve a variety so it will be more resistant to the early blight is very simple. All of the extra labor required in the latter case is to go into the field when the disease is at its worst, pick out the desired number of hills which show ability to resist the blight, mark them in some way (small stakes are very convenient for the purpose) and at digging time dig the marked hills by hand and save the seed in bulk. It is not necessary in this case to keep one hill separate from another. Only productive hills should be retained, however, as a non-productive hill, even though it be able to resist the blight, is not a good hill to select seed from. Enough seed can readily be secured in this way to plant a tenth of an acre or more if desired and the product of this will plant two or three acres the second season.

There are varieties of potatoes being offered on the market as "blight-proof" varieties. Blight-resistant or disease-resistant is a very different thing from blight-proof or disease-proof. The former means that a variety has within itself the power to resist disease up to a certain point. The latter, that the variety is immune, a condition which is not known to exist. Develop your own disease-resistant potatoes rather than buy a variety which is claimed, by someone else, to be "blight-proof."

DISCUSSION.

Mr. SPILLMAN. I may state that in a visit to New Jersey where sweet potato culture is a standard agricultural industry and has been brought to a very high state of efficiency, a great many of the breeders are using methods similar to those described by the author of the paper to which we have just listened, and with most excellent results. There are some farmers who would not think of planting seed which has not been selected according to that system. They have been doing that for some years.

Chairman GROUT. If there is no further discussion, we will proceed to the next topic, "Importance of Full and Accurate Descriptions of Varietal Differences in Growing Seed of Market Vegetables," by Mr. W. W. Tracy, of the United States Department of Agriculture.

IMPORTANCE OF FULL AND ACCURATE DESCRIPTIONS OF VARIETAL DIFFERENCES IN GROWING SEED OF MARKET VEGETABLES.

By W. W. TRACY, *U. S. Department of Agriculture, Washington, D. C.*

What I have to say refers to breeding and growing seed for use in producing market crops rather than to breeding for the production of new varieties, or even to the improvement, in the sense of modification, of old ones. Under modern methods of growing and marketing vegetables, uniformity, both of growth and of product, is a great desideratum, and variations in individual plants, even if it comes from the greater development of an intrinsically desirable quality, is a disadvantage. This can be made clearer by an illustration.

The profit or loss on a crop of green peas is often determined by a difference of a few days in the time when the pods reach a marketable size. In our best stocks of market sorts, all the plants mature their pods so nearly together that under the most favorable conditions the greater part of the crop can be gathered in a single picking; and it should never require more than three pickings all made within ten to fourteen days to secure practically all of it. Now if to a stock of peas, in which practically all the pods mature to marketable size in 50 to 55 days, we add 10 per cent of one which matures pods in 45, we have materially hastened the average date of maturity and so seemingly increased its value; but in reality we have materially reduced it for it is impracticable to make a special picking of this 10 per cent of early pods. To do so would so injure the vines as to reduce the total yield by much more than 10 per cent besides requiring the extra time in picking, while if these early maturing pods are left on the vines and gathered with the bulk of the crop, they become so mature as to lower the grade and value of the whole crop. So that in practice, while the use of a stock, all or nearly all of which was five days earlier, might more than double the receipts, the use of one, only 10 per cent of which was five days earlier, would materially lessen them. The same conditions hold with reference to other qualities. The uniformity of product is often as important a factor in determining the practical value of a lot of seed as is any other quality. The exhibitor may aim at the production of superlative individuals regardless of the general average; the market man must depend upon uniformly good quality and to him superlative individuals are often as objectionable as those which are markedly inferior.

The perfection of development of a plant is perhaps most largely

determined by its environment; but its character, the potentiality and limitation of development are inherent in the seed and are made up of the balanced sum of influences it inherits in varying degrees from each of its ancestors for an indefinite number of generations back. Under the best modern cultural conditions, the environment of different plants in a field is practically the same, but there is usually a great variation in the quantity and quality of the product, much, if not most of which variation is due to differences between individual seeds. There are few crops where the profit would not be greatly increased, and it could often be doubled, if the product of each one of the individual plants in the field were just equal in quantity and quality to that of the second best one-third of them.

I believe that improvement in this respect can come only through an appreciation on the part of seed growers of the importance of seed breeding and growing, of rigid adherence from year to year to precisely the same varietal types and such adherence can only be possible when such varietal types have been very clearly defined and described.

Do we have in the case of garden vegetables clear definite and explicit descriptions of just what any particular variety should be? I think not. In the case of plants propagated asexually, exact definitions of varietal characteristics is not so important. Since we cannot change it, we can only increase the number of parts of a certain definite thing—we cannot alter its inherent character. The Baldwin apple of to-day, of 50 years hence, is precisely the same in its character, its potentialities and limitations of development as that of 50 years ago. No matter how many propagative generations it may go through, the type of the variety as a variety cannot change; yet such men as Downing, Warder, and Beach have devoted years of earnest study, not only to the adaptability of the sort to certain places and uses, but to formulating clear descriptions of just what it is. On the other hand, in vegetables where the permanence of a variety and the retention of its qualities depends upon a clear statement of its distinguishing characteristics very litte work has been done, and it is not surprising that the slate-colored, nearly smooth-skinned Hubbard squash of 50 years ago drifts into the densely warted, dark-green Hubbard of to-day, which many claim is as unlike the original type in quality of flesh as it is in character of the skin, and no man can do more than guess what the Hubbard squash of 50 years hence may be. What the original introducer now selects as an ideal and typical ear of Premo corn is very different from one he picked out as an ideal five years ago when it was first named as a distinct variety. When we remember that the relative influence of each ancestor may vary in each individual and the great variation represented in the ancestry of the different plants of most stocks of garden vegetables, it is not surprising that they are variable, nor that some individuals are very different and of immensely greater practical usefulness than are others though they fail to transmit that superiority to their descendants. The only way we can secure seed certain to develop plants of an exact type is to make sure that each and all of its ancestors are of that exact type; and to do this,

we must have the type clearly defined and, in selection, adhere rigidly to it and not be tempted into the use of plants that vary from the type even though they be individually superior. The first requisite for this is the formation and general acceptance of minute and exact descriptions of varietal types. This is by no means an easy task. We must first distinguish between what are real varietal and hereditary characteristics, and those which are simply the result of environment of the individual, for it must be admitted that conditions of environment sometimes induce modifications in the character of the plant, and when the same conditions are continued from year to year they have a cumulative influence, the effects of which may become hereditary; but such variations are less common and generally far less important than characteristics which are inherent in the nature and habit of the plant itself and quite independent of environment. Again, the comparative and practical importance of variations should be considered. Often there are correlations of qualities through which a readily seen variation, which is of itself of little moment, becomes very important because it is very distinctly characteristic of the sort or is invariably correlated with some important quality which cannot readily be seen.

Again, the relative importance of certain qualities will vary with the conditions under which the plant is to be grown and the uses to which it is to be put. I have known of a number of instances when the very qualities which made a sort desirable for certain places and uses, and the development of which was the only reason for its existenc as a distinct variety, have been bred out of it; because, under the conditions and for the purposes with which the seed grower was familiar, these qualities were objectionable rather than desirable. These conditions make it seem to me that the formation of full, minute, and carefully written out descriptions of what the ideal plant of a variety shall be, and the rigid adherence in selection to that exact type from year to year, is the essential foundation for all really successful seed growing. And that there is to-day no greater horticultural need than the formation of such full and accurate varietal descriptions of vegetables as we now have of fruits.

THE INHERITANCE OF SIZE OF LITTER IN POLAND CHINA SOWS.

By GEO. M. ROMMEL, *Animal Husbandman, U. S. Department of Agriculture, Washington, D. C.*

Has the size of litter of Poland Chinas decreased? One of the most interesting studies on which the writer has been recently engaged is that of the size of litter of our American breeds of hogs and the inheritance of this characteristic from mother to daughter, especially as regards the Poland China breed.

Quite an exhaustive study of the size of litter in Poland China and Duroc-Jersey sows was recently completed by the writer and published as Circular No. 95 of the Bureau of Animal Industry. This work was first undertaken to ascertain if possible whether there had been a decrease as charged in the size of litter farrowed by Poland China sows. The American Poland China Record was first taken up and, at the suggestion of Prof. W. M. Hays, Assistant Secretary of Agriculture, it was planned to compare the records of the earliest five years for which a comprehensive number of litters could be obtained with the latest five years then available. These years proved to be 1882 to 1886, and 1898 to 1902. When the results were ready for comparison, it was found that 6154 litters farrowed from 1882 to 1886 had an average size of 6.87, whereas 29,506 litters farrowed from 1898 to 1902 had an average size of 7.49—an increase per litter in the twenty years of .62, a result that was indeed surprising. To publish such a result without confirmation seemed unwise and accordingly the Ohio Poland China Record was studied in the same manner. There it was found that 8749 litters farrowed from 1882 to 1886 averaged 7.16 pigs per litter and 10,306 litters farrowed from 1898 to 1902 averaged 7.59—an increase in twenty years of .43 per litter. Combining the results of the two records, there are 14,703 litters farrowed from 1882 to 1886 with an average of 7.04 and 39,812 litters farrowed from 1898 to 1902, with an average of 7.52, an increase for both records combined of .48 per litter. The large numbers employed and the two sources of information confirming each other, seemed sufficient to regard the evidence as correct, and the results were forthwith published with this statement:

An undoubted increase is evident, and the conclusion is inevitable that, contrary to popular opinion, the sows of the Poland China breed have increased in fecundity during the last twenty years. The increase shown above—0.48 per litter—is not extraordinary, but the numbers are large enough to indicate an increase in the fecundity of the breed as a whole. What was true of 14,000 litters twenty years ago was probably true of the entire breed, and what is true for 39,000 litters to-day is no less probably true for the entire breed. An increase of only 0.48 per litter in twenty years would not mean much, perhaps, to the man who was raising hogs for the butcher's trade; but these are animals intended for breeding purposes and sold at a great advance over butcher's prices, and therefore this increase represents a very substantial addition to the value of the breed. It is not possible to state what proportion of the litters observed in this work was farrowed by fashionably bred Poland China sows, against which the charge of diminishing fecundity is particularly directed; but as the pigs from such sows seldom, if ever, fail to be recorded in either the American or the Ohio record, the litters of fashionable sows are undoubtedly included in these calculations and have their influence on the general result. The most important point in these results is that the fecundity of the breed is not being lost, but, on the contrary, is increasing.

At the same time a similar study was made of the National Duroc-Jersey Record, but figures were not available for a sufficient time to give a basis of comparison to ascertain whether the fecundity of the

breed is increasing or decreasing. However, the results enable us to compare the fecundity of Duroc-Jersey sows with that of Poland Chinas. We can safely put the average size of litter of Poland China sows at 7.52 (the average for the years 1898 to 1902). That for Duroc-Jerseys, for 21,652 litters farrowed from 1893 to 1902, was found to be 9.26.

It is unfortunate that the same studies cannot be extended to records for other breeds. A comparison for Berkshire sows, for example, would be of the greatest interest.

The fact that the office had obtained an immense amount of material in this work which was valuable for further studies led up to the investigation on the inheritance of size of litter which was begun last year in collaboration with Dr. E. F. Phillips, of the Bureau of Entomology of the Department of Agriculture. The method used was that given in Davenport's "Statistical Methods" for the determination of the co-efficient of the correlation, which in this case when determined would show the degree to which size of litter was inherited from the mother by the daughter. 6145 cases were observed and they were arranged according to the ages of the daughters, from one to five years old, a final calculation being made for daughters of all ages—that is, from one to five years. There are some few cases where litters are recorded by sows over five years old, but these are so few that accurate results could not be obtained from them and they were accordingly eliminated. The litters studied were farrowed in 1902, and are recorded in the American Poland China Record, Volume 36 being the last from which data were taken. Of course there are a few 1902 litters in later volumes, but the number is not large enough to affect the result.

The method, briefly, was to compare the size of litters in which mothers were farrowed with that of those farrowed by daughters.

The following table shows the result:

Correlation in size of litter of Poland China sows between mother (M) and daughter (D), American Poland China Record.

Age of daughters.	Number cases.	Average M.	Average D.	σ M.	σ D.	r.	E.r.
1 year.....	2010	7.908	6.6451	2.0764	1.7582	.1088	±.0149
2 years.....	2047	7.6927	7.5598	1.9818	1.9415	.0885	±.0148
3 years.....	1157	7.5809	7.8799	1.9815	2.0693	.0888	±.0197
4 years.....	606	7.6304	8.2821	1.9856	2.0661	.0379	±.0274
5 years.....	325	7.6738	8.4031	2.1001	2.1571	.0032	±.0375
1-5 years.....	6145	7.7349	7.4391	2.0202	2.0812	.0601	±.0086

The first two columns of this table explain themselves. The third shows the average size of litters of mothers of the daughters of the different ages, and the fourth the average size of litters farrowed by the daughters of these ages. The fifth and sixth columns show the

standard deviations for mothers and daughters respectively. This standard deviation (σ) "is a relative measure, expressed in terms of the mean, of the concentration about the mean or average, and is therefore an excellent measure of the amount of variation." *

The seventh column shows the coefficient of correlation (r) in percentages and is in this case the measure of inheritance from mother to daughter. The last column shows the probable error of the coefficient of correlation (E.r) and indicates the probable limits of the coefficient of correlation. For example, $r = .1088 \pm .0149$ means that the true coefficient of correlation probably lies between .0939 and .1237. An absolutely correct result could, of course, only be obtained by using an infinite number of cases.

The points of special interest to the breeder in these results will be found in columns 4 and 7. In observing the size of litter farrowed by sows of all ages in 1902, an average of 7.4391 is noted, but when these records are arranged according to the ages of the sows, a regular increase in the size of litter is observed with the increase in the age of the sows. Yearling sows average 6.65 per litter, two-year-olds 7.56, three-year-olds 7.88, four-year-olds 8.28, and five-year-olds 8.40. In other words, a hog breeder makes a serious mistake in disposing of a sow after she has produced one litter, unless she is obviously a poor breeder, but should keep his good breeders two or three or even five years, taking advantage of the larger litters which she will farrow as she grows older. The results shown in column seven indicate the inheritance of size of litter from mother to daughter. For daughters of all ages it is 6.01 per cent, with a probable error of .86 per cent, but in studying the results for the daughters of the different ages, it is seen to decrease from 10.88 per cent in yearling sows, with a probable error of 1.49 per cent, to practically nothing in five-year-olds, the probable error being so large in the latter case that the coefficient of correlation for that age has no value. It is not possible to state the reason for this peculiar condition, but it may be that such factors as bodily function, maturity and nutrition have a larger influence than inheritance as the sow grows older and it has also been suggested that the inheritance from grandmothers and even more remote ancestors may enter into the determination with greater force with the increase in age. This greater inheritance from the immediate parent bears out the practice of breeders when inbreeding, to use young animals; and if a man wished to increase the size of litter in a herd of hogs, he would probably find best results from his young sows. This fact should not, however, cause him to forget the larger litters to be expected as the sows grow older.

The inheritance of fecundity and fertility in thoroughbred and man

* Rommel, G. M., and Phillips, E. F., Inheritance in the Female Line of Size of Litter in Poland China Sows. Jour. Amer. Phil. Soc., 1907.

has been studied by Pearson, Lee and Bramley-Moore,* of England, with which results those of the author and Dr. Phillips agree in a general way. This subject is being studied further to determine the inheritance through the male line from grandparents and more remote ancestors.

The following are the correlation tables used in the study of inheritance of size of litter through the female line. They will, no doubt, be found interesting:

Correlation tables of size of litters of sows with size of litters in which dams were farrowed. American Poland China Record.—Litters of 1902.

TABLE I.—YEARLING SOWS.

Size of litters in which dams were farrowed.	Size of litters of yearling sows. 1	2	3	4	5	6	7	8	9	10	11	12	13	Totals.
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	—	—	—	2	2	1	1	—	—	1	—	—	—	7
3	—	4	2	1	2	3	4	2	2	1	—	—	—	21
4	—	—	3	5	22	20	10	4	6	—	—	—	—	70
5	—	1	4	15	26	28	24	15	5	6	1	—	—	125
6	—	1	3	21	34	65	81	43	18	7	2	—	—	275
7	1	4	4	27	47	89	89	62	31	12	2	—	—	368
8	1	1	10	31	65	67	81	61	34	12	3	1	1	368
9	—	1	5	21	53	76	87	67	35	14	10	1	1	371
10	1	1	4	14	16	38	48	36	23	6	6	—	—	193
11	—	2	2	8	20	21	22	22	13	7	4	—	—	121
12	—	1	1	4	7	15	12	8	4	1	2	1	—	56
13	—	—	3	2	4	6	1	5	—	1	—	—	1	23
14	—	—	—	—	1	2	3	2	1	1	—	—	—	10
15	—	—	—	—	—	—	—	—	—	1	—	—	—	1
16	—	—	—	—	—	—	—	—	—	—	—	—	—	—
17	—	—	—	1	—	—	—	—	—	—	—	—	—	1
Totals	3	16	41	152	299	431	463	327	172	70	30	3	3	2010

TABLE II.—TWO-YEAR-OLD SOWS.

Size of litters in which dams were farrowed.	Size of litters of two-year-old sows. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Totals.
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	—	—	—	1	—	—	1	2	—	1	—	—	—	—	—	5
3	—	—	—	2	4	2	2	4	6	2	—	—	1	—	—	23
4	—	—	3	4	3	10	14	10	12	2	3	1	1	1	—	64
5	—	—	3	6	10	33	34	36	27	6	6	2	—	—	1	164
6	1	2	7	15	26	52	70	68	36	27	8	4	1	—	—	317
7	—	2	5	10	25	71	86	84	59	32	12	2	2	1	—	391
8	—	7	4	15	36	55	95	78	64	32	11	6	4	1	—	408
9	1	2	2	8	20	36	61	65	70	33	20	4	1	1	—	324
10	—	—	1	5	14	30	33	45	23	14	15	6	1	—	—	187
11	—	2	1	2	7	4	21	21	15	13	7	2	—	—	1	96
12	—	—	2	1	4	10	9	9	2	4	3	1	—	—	—	45
13	—	—	—	—	1	3	2	3	4	1	1	—	—	—	—	15
14	—	—	—	—	—	—	3	1	1	1	1	—	1	—	—	8
Totals	2	15	28	69	150	306	431	426	319	168	87	28	12	4	2	2047

* Phil. Trans. Roy. Soc. London, A, Vol. 192, pp. 257-330.

TABLE III.—THREE-YEAR-OLD SOWS.

Size of litters in which dams were farrowed.	Size of litters of three-year-old sows.																Totals.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	—	—	—	—	—	1	1	1	1	—	—	—	—	—	—	—	—	4
3	—	1	—	1	2	1	2	4	5	—	—	1	—	—	—	—	1	18
4	—	1	—	—	2	3	6	9	7	6	2	—	1	—	—	—	—	37
5	—	1	1	5	11	17	15	22	16	4	3	3	1	—	—	—	—	99
6	1	1	3	5	14	27	37	29	35	14	12	3	—	—	—	—	—	181
7	1	—	2	9	19	25	50	48	31	34	12	4	2	—	—	—	—	237
8	1	—	5	3	13	31	40	47	35	22	18	2	3	—	1	1	—	222
9	—	—	—	3	8	17	33	30	31	24	8	2	3	2	—	—	—	161
10	1	—	3	—	6	11	16	25	24	17	4	—	1	1	1	—	—	110
11	—	—	—	4	5	5	14	13	12	6	4	3	1	—	—	—	—	67
12	—	—	1	—	—	2	3	1	2	4	5	—	—	—	—	—	—	18
13	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1
14	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	1
15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
16	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1
17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Totals..	4	4	15	30	80	141	217	230	200	131	68	18	12	3	2	1	1	1157

TABLE IV.—FOUR-YEAR-OLD SOWS.

Size of litters in which dams were farrowed.	Size of litters of four-year-old sows.															Totals.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1	—	—	—	—	—	—	—	1	—	—	—	1	—	—	—	2
2	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	2
3	—	—	1	—	1	—	1	2	1	3	—	—	—	—	—	9
4	—	—	—	1	—	2	5	5	4	3	2	2	—	—	—	24
5	—	—	—	2	3	5	6	11	8	7	2	—	—	1	—	45
6	—	—	—	2	6	7	13	18	8	17	3	2	1	1	—	78
7	—	1	—	2	6	13	22	24	32	16	4	2	—	1	—	123
8	—	—	1	3	5	10	15	23	26	24	6	6	1	1	1	122
9	—	1	1	3	8	9	18	18	15	20	10	1	2	3	—	109
10	—	—	—	1	4	5	5	10	8	11	3	—	—	1	—	48
11	—	—	—	2	2	5	1	5	6	1	5	2	1	—	—	30
12	—	—	—	—	1	2	—	1	2	3	1	—	—	—	—	10
13	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	2
14	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—	2
Totals	—	2	3	16	36	60	87	118	111	107	36	16	5	8	1	606

TABLE V.—FIVE-YEAR-OLD SOWS.

Size of litters in which dams were farrowed.	Size of litters of five-year-old sows.															Totals.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	1
3	—	—	—	—	1	—	—	1	2	—	—	—	—	—	—	4
4	—	—	—	—	—	2	1	2	3	2	—	—	—	—	1	11
5	—	—	—	—	1	3	3	6	6	4	2	2	—	—	—	27
6	—	1	1	1	4	8	4	10	6	8	7	1	1	2	—	54
7	—	—	—	1	1	8	12	10	13	11	6	1	3	—	—	66
8	—	—	—	2	3	3	11	14	10	4	3	3	—	—	—	53
9	—	2	—	2	4	3	8	11	12	6	4	2	—	—	—	54
10	—	—	—	1	—	4	3	5	4	3	3	2	1	1	—	27
11	—	—	—	—	—	1	3	2	2	4	1	—	—	—	—	13
12	—	—	—	—	—	—	1	2	1	—	—	—	1	—	—	5
13	—	—	—	—	1	—	1	1	1	1	2	—	1	—	—	8
14	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—	2
Totals	—	3	1	7	15	32	48	64	61	43	28	12	7	3	1	325

TABLE VI.—ALL LITTERS, 1902.

Size of litters in which dams were farrowed.	Size of litters of sows one to five years old.																Totals.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
1	—	—	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—	2
2	—	—	—	3	2	2	3	3	2	3	—	1	—	—	—	—	—	19
3	—	5	3	4	10	6	9	13	16	6	—	1	1	—	—	—	1	75
4	—	1	6	10	27	37	36	30	32	13	7	8	2	1	1	—	—	208
5	—	2	8	28	51	86	82	90	62	27	14	7	1	1	1	—	—	460
6	2	5	14	44	84	159	205	168	108	78	32	10	3	3	—	—	—	905
7	2	7	11	49	98	206	259	228	166	105	36	9	7	2	—	—	—	1185
8	2	8	20	54	122	166	242	223	169	94	41	18	9	2	2	1	—	1173
9	1	6	8	37	93	141	207	191	163	97	52	10	7	6	—	—	—	1019
10	2	1	8	21	40	88	105	121	82	51	31	8	3	3	1	—	—	865
11	—	4	3	16	34	36	61	63	48	31	21	7	2	—	1	—	—	327
12	—	1	4	5	12	29	25	21	11	12	11	2	1	—	—	—	—	134
13	—	—	3	2	6	11	5	9	5	3	3	—	2	—	—	—	—	49
14	—	—	—	—	1	3	7	3	4	3	1	—	1	—	—	—	—	23
15	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	1
16	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1
17	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Totals	9	40	88	274	580	970	1246	1165	868	519	249	77	39	18	6	1	1	6145

DISCUSSION.

Mr. ROMMEL. A great many hog breeders make it a practice to dispose of their sows after they have farrowed their first litters. If a man has some 100 sows, that is going to make a difference to him in his final totals at the end of the year, year in and year out. He ought to keep those sows if they are good breeders, till they have reached their prime; but, of course, when they begin to decline he should get rid of them. Where the prime is, as far as this character is concerned, our figures do not show, because there was a constant increase up to five years. Certainly the sows could be very profitably kept for three or four years.

Although there is not a great deal of absolutely definite information on the subject, it appears, as we would naturally expect, that the size of litter is inherited from the mother by the daughter. The inheritance is not very large, but it is there. In other words, if you want to increase the size of litters farrowed by your hogs, select sows that come from large litters. That is the whole thing in a nutshell.

Now here is what we cannot understand, that that point of inheritance is crossed in the youngest sows; in other words, in our 2000 yearling sows there was 11 per cent of correlation. In the year following there was 8.8. In the third year there was a little less. The twos and threes were about equal. But it began to go down the fourth year to 3.79, and the fifth year to practically nothing. Furthermore, the probable error in these results is so great in the cases of the four-year, six-year, and five-year-olds, that the results are practically of no account; in other words, we cannot say that there is any inheritance from the mother by the daughter of this particular character when we reach the ages of four years and five years old. We do not know why that is. Our figures so far as we have gone are correct. They were worked over by two persons. It may be that some other factor entered there having a greater influence than age, of course; it might be nutrition, it might be bodily function, or it might be something else, we do not know. It has been suggested that it is inheritance from a more remote ancestor. As to that we cannot say anything, not having looked into it. The Doctor and I are working still further on this problem, and we hope to study the problem of the size of litter from the male line also.

Chairman WARD. Before adjourning, the Secretary will read a list of papers that we have not had time to have delivered, which will be considered as read, and will be published in the proceedings.

Secretary Mowry read the following:

MEMORANDUM OF PAPERS READ BY TITLE.

Breeding Oats. By J. B. Norton.
The Evolution of the Bacon Type. By Hon. John Dryden, Toronto, Can.
A Plant Breeder's Trip to Eurasia. By Prof. N. E. Hansen.
Report of Committee on Breeding Tree and Vine Fruits. By S. A. Beach.
Method of Pedigree Breeding Recommended for Improving Cotton. By Dr. Herbert J. Webber.

Report of Committee on Breeding Forest and Nut Trees. By Geo. B. Sudworth and A. D. Hopkins.
Report of Committee on Breeding Forage Plants. By J. H. Shepperd.
Report of Committee on Breeding Bees. By L. O. Howard.
Report of Committee on Cooperative Work in Plant Breeding. By Dr. A. F. Woods.
Results in Growing Gladioli. By H. H. Groff.
Prevention of Degeneration the only Practical Eugenics. By Dr. C. E. Woodruff.
Statistics of Cotton Variation. By D. N. Shoemaker.
Selection of Seed Corn. By Director C. D. Smith.
A Plea for the More Extended Use of the System of Live-Stock Registration. By M. M. Boyd.
Report of Committee on Breeding Poultry. By Prof. J. E. Rice.
Grading in Agricultural Judging Contests. By L. J. Briggs.
Introducing New Varieties of Plants. By C. W. Ward.
Report of Committee on Breeding Carriage Horses. By Dr. Geo. M. Rommel.
The Future of the American Shorthorn. By Joseph E. Wing.
Report of Committee on Breeding Vegetables. By Prof. R. A. Emerson.
Report of Committee on Breeding Horse Hybrids. By Prof. F. R. Marshall.
Methods in Seed-Corn Breeding. By Eugene Funk.
Contribution to the Report of the Committee on Breeding Wild Animals. By C. J. Jones.
Evolution and Mutation. By Prof. Hugo De Vries.
Need of Purebred Stocks of Animals in the South. By Prof. C. A. Cary.
Report of Committee on Breeding Fiber Crops. By L. H. Dewey.
Improvement of Citrus Fruit Varieties. By E. J. Wickson.

Whereupon the Convention adjourned *sine die*.

The following papers read by title at the annual meeting at Columbus are here included as a part of the annual report.

THE EVOLUTION OF THE BACON TYPE.

By Hon. JOHN DRYDEN, *Toronto, Canada.*

The evolution of the bacon hog in Ontario Province was, without doubt, the highest achievement of the Department of Agriculture while under the guidance of the writer as its head.

Times of deep depression existed among our farmers in the early nineties. Products which had brought a good revenue were no longer wanted. Grain had occupied for many years the chief place among farm products, but the cereals were no longer profitable. It was necessary to turn to other lines of production. Among those which at that time appeared likely to give some relief was the production of superior bacon for the English market; but our swine were not suitable for the purpose. The Ontario farmer had developed the thick fat type, using Berkshire, Chester White, Poland China, and like breeds. As bred at that time none of these were suitable for prime bacon. After a few years, Tamworths began to be introduced and also the small Yorkshire. These were used for crossing on the other breeds, but

only with partial success, and, what was worse (looking to the future), many influential farmers refused to use what were then called "Razor-Backed" Hogs, having been always accustomed to the so-called easy feeding breeds. Over and over again, the writer was told that if the Department could present them with these lean breeds, they would not keep them on the farm. We could not coerce them, of course. How then could they be convinced as to the only proper course to take? This was the problem which faced the Agricultural Department. If we were to make an impression on the English market it was necessary to produce a good bacon type over the whole country, and not merely at a few points. Some progress had been made in a few districts; but, generally, the quality of those offered was away below the proper type. At that time we had an annual perambulating Fat Stock Show, supported in part by public funds. Experience, however, soon convinced those in authority that to see the animals was not sufficient. Information must be given, but this could not be done without a proper meeting place, and that must be in connection with the show buildings. Accordingly, a settled home was found at Guelph where extensive buildings were erected, not merely housing the show, but furnishing an appropriate lecture room where the live animals could be taken on to the platform, as also a killing room, and a cooling room. With these appliances the educating campaign proceeded as follows: Large prizes were offered for bacon hogs of suitable weight ready for slaughter. The pork packing companies were asked for three experts to judge them. These were instructed not only to select the best, but that if none offered reaching the ideal of first-quality bacon, no first prize should be given, nor second, nor third for similar reasons. The first year we failed to find the ideal pig, and accordingly no first nor second prize was awarded. The second year showed much improvement, while the third year brought several specimens which were fit to rank as first class. Then came our educational campaign. All the speakers for our Farmers' Institutes were asked to be present and listen to the discussions. The ideal hog was brought on the platform along with others of an opposite type. The experts from the packing houses were asked to explain to the large audiences why this type was required and what class of bacon it would produce. The audience had full latitude to question the speakers. The same evening these pigs passed through the killing room and the next afternoon were presented in the form of sides of bacon, so that the first day's lesson was verified and the conclusions were shown to be correct. This course convinced the most skeptical and the murmurings about the breed very soon entirely ceased. But this work did more. It enabled those breeding foundation stock to discover the particular form of animal which, when slaughtered, gave the best bacon. Careful selections were made by some of our best breeders until I am ready to-day to make the claim that in the Province of Ontario we have a type of bacon hog not excelled in any country the world over.

But our efforts at this show, now known as the "Winter Fair," could

not reach the masses of our people. To do this, the farmers' institute system was utilized. It covers every electoral division in the Province. In each of these, meetings of farmers are held annually. The speakers, after their attendance at Guelph, where the lectures and discussions had been held, were prepared to speak on the subject with accuracy and authority. The bacon hog was made a compulsory subject for three years by the Department, so that in every county, over the whole Province, the gospel of superior bacon was declared almost simultaneously. The living animal could not be used in halls and school houses, but a substitute was found in large-sized photos of the ideal hog, as well as the sides of bacon as shown at Guelph. Thus, in every county and practically at every meeting, the various speakers were telling the same story. At the end of the third year, the work was so well done that at every shipping point the uniformity of the hogs became a subject of general comment. The ultimate result is now seen in the place Canadian bacon has won for itself on the English market. In order to produce the foundation stock for the best bacon production, no breeder in our country has resorted to close inbreeding. The present high and uniform quality has been attained entirely by selection based on the killing tests. The animals reserved for breeding in the pure-bred herd were selected to supply the same type which year by year won first place in the killing test. The result is that, along with a wonderful uniformity and excellence, we have a ruggedness and strength of constitution very much to be desired. Besides, our ideal animal is not ugly in appearance. In fact our farmers generally have concluded that " Handsome is as handsome does."

REPORT OF THE COMMITTEE ON BREEDING TREE AND VINE FRUITS.

By Prof. S. A. BEACH, *Chairman, Ames, Ia.*

Professor T. V. Munson, of Denison, Texas, began a special line of investigation in 1905 in connection with his well known work in grape breeding. He is endeavoring to determine the actual and relative degrees of sweetness and acidity in different varieties of grapes. Work was undertaken too late to include the earlier ripening varieties in 1905, but some notable results were obtained. For example, Concord proved to be the lowest in sugar of any out of some 40 varieties which he tested. Prime well-ripened Texas Concord's had 61° sugar, Oeschles scale and 4° acid, Twitchell's acidometer, while prime Concord from Lawton, Michigan had 59° sugar and 9° acid. Professor Munson's report on his work for the season of 1906 has not yet been received.

Professor S. B. Green, of the Minnesota Experiment Station, outlined some important work in breeding tree and vine fruits. That

Station has about 5 acres planted to seedling plums, apples, and grapes. Seed from 18 barrels of Malinda apples has been planted. The Malinda trees from which this fruit was obtained were grown on Oldenburg stock and it is supposed that the seeds for the most part are crossed with Oldenburg. Some cooperative work is in progress at Lake City, Minnesota, in crossing Burbank, Damson, and Americana plums. Professor Green has not yet submitted his report of this work for 1906.

A notable effort has been made during the past year to secure more thorough cooperation between the United States Department of Agriculture and various agricultural experiment stations in the matter of securing from various parts of the world types or races of the apple which seem to offer material in any way desirable for breeding apples for various portions of the United States and particularly for those regions where the need of improved varieties is most keenly felt. The horticulturists in attendance at the Graduate School of Agriculture in Urbana in 1906 formulated the following statement:

The apple is the most important fruit grown in this country, and is destined to become more and more so in the development of our horticultural industries. Beyond doubt it is possible to extend its cultivation into districts where it has not yet become established, by discovering or developing new varieties adapted to these districts. It is also feasible to breed better varieties for the districts where apple growing is already established.

In order to make most rapid and efficient progress in this direction, the world should be searched for the best materials to use in this work. It is necessary to learn (1) in what regions of the world the business of growing apples is of any considerable importance; (2) the climatic and soil conditions of these several regions and the chief commercial varieties there grown; and (3) what races or strains of *Pyrus malus* and other species of apples show sufficient resistance to cold, heat, drought, or disease, to make them useful in breeding varieties which may extend apple growing in America both north and south of its present limits. For this information not only Europe and Asia but Australia and South America should be searched.

Since the collecting of such information and the importing of such material for the work of breeding apples at our Experiment Stations may best be done through cooperation with the United States Department of Agriculture, the horticulturists in attendance at the Graduate School of Agriculture at the University of Illinois, unanimously request that this matter be presented to the Honorable Secretary of Agriculture and that he be urged to undertake this research and importation to advance the interests of American Horticulture.

This matter was presented to Secretary Wilson by a committee representing the horticulturists above referred to. The proposition was received with favor by Secretary Wilson who called attention to the work along this line which has already been done by the Department of Agriculture and stated that he would endeavor to secure any material of the kind mentioned which could be found.

The matter was referred by him to B. T. Galloway, Chief of the Bureau of Plant Industry, and to D. G. Fairchild, in charge of Foreign

Explorations and Plant Introduction, who both expressed great interest in the prosecution of this line of effort. As a result arrangements have already been made to distribute a valuable collection of Pyrus material in the spring of 1907. This material is to be sent to the experiment stations listed below:

St. Anthony Park, Minnesota.
Madison, Wisconsin.
Fargo, North Dakota.
Brookings, South Dakota.
Lincoln, Nebraska.
Ames, Iowa.
Urbana, Illinois.
Columbia, Missouri.
Mountain Grove, Missouri.

METHOD OF PEDIGREE BREEDING RECOMMENDED FOR IMPROVING COTTON.

By HERBERT J. WEBBER, *Chairman of Committee on Breeding Cotton, Washington, D. C.*

PLAN FOR WORK OF COMMITTEE ON BREEDING COTTON.

It has been impossible for this committee to meet together, but by correspondence it has been pretty well determined what work the committee should undertake. It is the belief of the committee that in the breeding of cotton the most important work to pursue first is to investigate and standardize the methods to be used in breeding this crop. In corn breeding the methods of pedigree selection have been fairly well worked out, so that outlines are published here and there according to which work can be taken up by individual corn breeders or breeding associations and the methods can be adapted to the needs of the individual or association. The methods for cotton have not been so well worked out and doubtless many improvements can be made. The method of breeding to be pursued, furthermore, must in many cases be varied in accordance with the particular improvement sought.

The members of the committee on cotton breeding are all actively engaged in the breeding of cotton and as their work progresses it is probable that further light will be thrown on the now doubtful points. The committee believes that the best way to bring the information together is each year to have one or more of its members present individual papers, giving outlines of the methods which they have found most desirable and satisfactory; such papers to be published as parts of the committee's report. Following this policy the chairman of the committee has this year prepared a brief report on the "Methods of Pedigree Breeding Recommended for Use in Improving Cotton," a copy of which is herewith submitted.

In an article on the "Improvement of Cotton by Seed Selection" in the 1902 Year Book of the Department of Agriculture, the writer described in some detail the methods which had been found most satisfactory to use in the selection of cotton. At this time little systematic

work had been done in improving cotton and the methods to be used were not well worked out. Experience has shown that some modification should be made in the method there described in order to adapt it to the needs of the practical breeder seeking to improve and pedigree a strain of cotton for his own use or to secure improved seed for sale. The outline method described in this paper will necessarily be lacking in detail, as a full description would occupy too much space.

It is important that it be recognized that the method described here is intended for use only in the improvement and production of pedigree seed of a standard race and not in the production of new races. When the breeder is experimenting in the production of new races the number of plants selected will depend entirely on the number found showing the desired new character, and it may frequently occur that only a single plant of the type desired can be found. Under these conditions it may be desirable to plant this one individual in an isolated patch in order that it shall not be cross-fertilized with plants of other types. Again, in such a case the breeder may wish to plant very few seeds in a place in order to secure the largest possible number of plants from the selected individual, and at the proper time rogue out all of the plants which do not come true to the type selected. This method, frequently to be recommended in the work of breeding new strains, precludes the use of the plant-to-row method and prevents the determination of comparative transmitting power records. As soon as such a new race has become fixed in its principal character it will then be desirable to put it through a course of systematic selection for several years following the method here described.

STANDARDIZING TEST PLATS.

In the cotton breeding work which has been done heretofore it has been the policy mainly to plant the different individuals in rows the same as ordinary cotton is planted, and this is the policy pursued commonly also in the testing of varieties. The experience of the writer and his various assistants in connection with cotton breeding work of the Department of Agriculture has led to the conclusion that it is very important to plant the selections and also variety tests in a different way where it is possible. It is highly important that each plant be given exactly the same space in order that, so far as possible, all of the plants may be grown under the same conditions. The labor conditions are such in the South that ordinarily it is impossible to have the cotton chopped out to a standard distance and it seems also almost impossible to get the plants uniformly thinned down to a single plant in a hill. The determination of variety yields and progeny yields necessitates practically that a count of the different individual plants be made and the yields then obtained by such counting are not comparable unless each plant has been grown under the same conditions. The writer would thus strongly advise that in the breeding patch where selections are planted, and also in variety tests, the plants be placed

in rows both ways across the plat. It is highly important in the case of breeding work that a uniform field be selected which is fairly level land, so that the rows may be run straight. The size of the plats will necessarily vary with the conditions. If the land is level, so that the plats can be laid out in the handiest way, it would seem to the writer that some system should be adapted so that a single row forms a certain fraction of an acre. On land of ordinary strength the writer would suggest that a convenient method would be to make the rows 363 feet long and 4 feet apart. If planted in this way 30 rows make an acre. By placing the hills 3 feet apart in the row the land on the acre is entirely and uniformly utilized, making 121 hills per row. By this system 15 rows would make a half acre, 6 rows a fifth of an acre, and 3 rows a tenth of an acre. Where individual selections are planted in adjoining rows usually about 121 plants could be planted with the seed from a single selection, and in this case all of the selections would have exactly the same number of plants and a single row planted with a selection would be one-thirtieth of an acre, making it easy to figure up the yield per acre from a single row which represents the progeny of one select plant. Following this method of placing the rows 4 feet apart and the hills, each containing a single plant, uniformly 3 feet apart in the row, having them rowed both ways, there would be 3630 plants per acre and each plant would have a space of 12 square feet.

If the land is light and the above spacing is thought to be too great to give best results the writer would advocate placing the rows 3 feet apart and the plants as above, 3 feet apart in the row. By this arrangement 40 rows of 121 plants per row would make exactly an acre. In this case the acre would contain 4840 plants and each plant would have 9 square feet of space for its development. The necessity of using level land and some such regular system of planting the selected cotton so that the field is rowed both ways, is believed to be of the greatest importance in the systematic selection of cotton. Following this method or any other method, it is of the greatest importance furthermore that only a single plant be left in a hill, and the laborers who thin the cotton should be carefully trained when thinning to leave the best plant in the hill.

TESTING VARIETIES.

If the breeder is to make the most rapid progress he should carefully study varieties and by experiment determine what sorts give the best results under the conditions for which he is breeding. The study of the local adaptability of the varieties is exceedingly necessary and the writer would advise every breeder who is starting work to first make careful tests of varieties, running over a period, if possible, of two or three years, and using at least 15 or 20 of the most promising varieties. In making such tests if the land is laid out as indicated above so that 30 rows 4 feet apart, or 40 rows 3 feet apart, make an acre, it is a

very easy matter to plant the several varieties in alternate rows and determine their comparative yields. In making such tests it is to be recommended that the different varieties used be planted so that only one row of a variety is located in one place. Probably the best policy is to plant one row of all the varieties and follow this with another planting of a single row of each of the varieties and so on throughout the patch until the desired number of rows of each variety has been planted. It is probable that one-fifth acre plats will give fairly satisfactory comparative yields when the rows are carefully checked and the plants are placed at equal distances, as indicated above, and if the rows are 4 feet apart 6 rows would make one-fifth of an acre. In every case of a variety test it is exceedingly necessary that the product of each variety be picked separately and weighed. In the writer's experiments he first thought that it would be possible to determine the comparative yield by the appearance of the plants. However, experience has shown him that it is impossible to judge of the product of a cotton plant by sight. Two rows which are undistinguishable so far as their appearance is concerned may vary from 20 to 25 per cent in actual yield. Such careful variety tests should serve to show the breeder what varieties are the best suited to the conditions under which he is working, and his pedigree breeding work should thus be done in the further improvement of these varieties.

SELECTION OF TYPE IN BREEDING.

After having tested varieties and determined in general what variety is best suited to the local conditions, grow a large field of this variety on soil which is as uniform throughout as can be selected. Give this field ordinary cultivation. The next step in the breeding is to determine what type of plant of this variety is the best. Ordinarily plants should be selected of medium height and stocky, which have the habit of putting on numerous bolls early in the season on the lower branches. A careful study of the plants in the field will enable the breeder easily to determine the best type of plant. It is the one which, in general, gives most cotton early in the season. Earliness in almost all cases is an important point, and in sections threatened by the boll weevil and boll worm earliness of maturity should always enter into the consideration of the type of plants selected as above. The type of plant selected will largely depend upon the variety and no general description can be given.

SELECTION OF PLANTS.

After having determined the type of plant which is thought to be most desirable the next process is to make the actual selection of plants. This selection should be made just before the first picking. Delay the first picking until the cotton is pretty well open and needs picking rather badly. Then go over the field row by row, walking slowly along each row and letting the eye have sufficient time to size up each plant.

The great majority of the plants can be thrown out at a glance. When good plants are observed examine them carefully and if they are up to what is considered the highest standard, mark them by tying a strip of white rag to one of the upper limbs where it will show plainly. The breeder usually selected from a large field possibly about one hundred of the best plants. In marking the plants the first time probably two or three hundred will be marked. After this first preliminary examination the field should be gone over a second time and the marks removed from any plants which are not truly superior plants, in this way reducing the total number probably to about 100 marked plants. In this second examination attention should be given to the amount of lint on the seed, as this in general determines the lint turnout and is important. The breeder should be provided with a small aluminum pocket comb about 4 inches long, which can be used to separate and straighten out the fibers on the seed, so that the covering or amount of fibers becomes plainly visible, as well as the length of the fiber. Every cotton grower should learn this method of cotton combing, as it is essential to the careful judging of cotton. By using the fingers the cotton on the seed can be separated and parted down the middle of the seed and then carefully using the comb, holding the fibers meanwhile to prevent them from being torn off the seed, the fibers can be combed out straight. In this way the amount of lint on the seed, the length of lint, and the uniformity of length become clearly visible and easy to judge. The process of combing requires some practice before it can be done successfully, but it will well repay the time spent in learning. As one goes over the plants, either the first or the second time, several seeds from different bolls on each selected plant should be combed out, and any plants in which the seeds are not well covered with lint of good length, should be discarded. In ordinary short-staple cotton no plants should be taken for seed which do not produce lint at least one inch in length. In the long-staple uplands the standard of length will necessarily depend on the variety being grown, as some sorts produce a $1\frac{3}{8}$-inch lint, while others produce as high as $1\frac{5}{8}$-inch lint.

In going over the plants the second time take all of these important points into consideration and retain only those which are the very best plants and which represent the highest type. These plants should be plainly labeled and numbered and the product of each plant should be picked separately in a paper bag numbered to correspond with the number on the plant. The best paper bags to be used in picking and preserving separately the product of each of the selected plants is the ordinary manila paper bags of about 8-pound size, which can ordinarily be purchased in any grocery store. The first pick can be made in these numbered bags and preserved, and the same bags can be taken into the field and the second or later picks placed in them, comparing the numbers on the plants and bags each time to see that the product of each plant is kept together.

NUMBERING THE FIRST GENERATION SELECTIONS.

It is important that some careful system of numbering the various selections be adopted, so that the pedigree of each individual can be carefully recorded and followed. The writer would suggest that for the use of practical breeders, who are working with comparatively few varieties, the first generation selections be given simply consecutive numbers and referred to under the name of the variety; for instance, they may be numbered Truitt-1, Truitt-2, Truitt-3, etc., or Triumph-1, Triumph-2, etc., the name of the variety serving to separate the different selections. It is very important if the breeders are to know what advance is being made that records be preserved showing the weight of seed cotton and lint produced by each select plant, the comparative earliness, and other qualities which are considered in the selection. Preservation of such notes regarding selected plants will enable the breeder to make a comparison of plants selected in various years and will greatly enhance the value and interest of the work.

GINNING THE SELECTED PLANTS.

At the close of the season some special arrangement should be made so that a single gin can be disconnected from the stand of gins and used to gin the product of the various selected plants. The gin should be arranged so that the seed cotton of a single plant can be fed in and ginned. After the product of each plant is ginned, the seed should be carefully selected and placed back in its numbered bag. It is highly important that the seed from each plant be kept separate and free from admixture of seed from other plants. Small gins are manufactured by the Continental Gin Co., which can be operated with a crank and which are fairly suitable for the ginning of these individual selections. Growers and experimenters who are giving especial attention to the breeding of cotton should certainly be provided with small gins of this sort for ginning the selections.

PLANTING THE SELECTIONS BY THE PLANT-TO-ROW METHOD.

The second year of the breeding a field should be selected for the breeding patch which has good soil, typical of the region, so far as possible. It is important that the soil throughout the patch be of uniform quality and kind, and not "patchy." Do not select the richest and best land available, as this may differ from land on which the improved variety is later to be grown. The breeding patch, if possible, should be isolated from any other cotton field a distance from 500 to 1000 feet at least. This is in order to avoid crossing or mixing with different varieties and unselect stock. Such isolation is very important if we are to avoid deterioration. A good place to put the isolated plat is in the middle of a corn field, where it is surrounded for some distance on each side by corn. If such an isolated patch cannot be provided, the breeding patch may, as a second choice, be planted in one corner of a cotton field which is planted with seed of the same variety from which the selections were made the preceding year.

Under no conditions place the breeding patch in close proximity to cotton of other kinds or varieties. The writer would urge that an isolated patch be provided in all cases, as this insures that all fertilization will be by pollen from plants coming from selected mothers.

One of the most important factors in all breeding work is to plant different individuals separately, so that the progeny of a select plant can be examined and compared with other progenies in order to see how the different selections have held up in their transmitting power. A plant to be good must necessarily have the faculty of transmitting its good qualities to its offspring. In order to determine the transmitting or progeny power, it is necessary that the progeny from a single plant be planted by itself, and the writer would advise cotton breeders to plant a single row with the seed from each select plant, so that we have a plant to a row. He would advise that the rows of the breeding patch be planted in accordance with the suggestions made above under the heading of "Standardizing Test Plats," placing about 121 plants in a row and having the rows in the field 4 feet apart and the plants 3 feet apart in the rows; planting by this method the progeny from a single plant would occupy one-thirtieth of an acre. A good plant which is selected should produce from 800 to 1000 seeds, and, therefore, there should be enough seed for planting the 121 hills, placing from 4 to 6 seeds in a hill.

The breeding patch should be given the same manuring and cultivation that is given the ordinary crop. The writer believes that it is not advisable to manure a breeding patch heavily, as this heavy manuring tends to increase the variation abnormally and to prevent the type of plant from showing. There is some evidence to indicate that, in selecting to increase the yield, more rapid progress can be made by planting plants on rather sterile soil than by putting them into soil of even ordinary fertility. This matter, however, is still in doubt.

EXAMINATION AND SELECTION OF PROGENIES.

When the cotton in the breeding patch is well opened and it is important that the first picking be made, go over the patch very carefully and study the progenies from the different selected plants. It is important to determine which of the plants selected the first year has transmitted to its progeny in the greatest degree the good qualities of high yield, good lint, etc., for which it was selected. The determination of the transmitting power is probably the most important point to be determined in all breeding work, as a selected plant to be good must have the property of transmitting its desirable qualities. A careful comparison of the hundred or more progenies from the different selected plants will usually result in the breeder finding a few progenies or rows which are, as a whole, superior to the others. When these have been found they should be marked and the individual selections for continuing the breeding should be taken from these rows or progenies. It is important that more selections be made than are intended to be preserved, as a progeny which looks good in the field

when picking is being made, may, on the weighing up of the total product of the different rows, prove to be inferior to some others, and the best progenies can only be determined after the products have been weighed up.

MAKING THE SECOND GENERATION SELECTIONS.

After the best progenies in the breeding patch have been selected the breeder should then carefully go over these progenies plant by plant and select and mark those plants which are found to be the most productive and which come up to the standard set for length of lint, abundance of lint on seed, type of plant, etc. These plants as selected should be marked and numbered as in the case of the year preceding, and careful records should be made of the important characters of each.

NUMBERING THE SECOND GENERATION SELECTIONS.

A system of numbering the second generation which will show their pedigree at a glance is as follows: If, for instance, one of the best progenies is from the original selection Truitt-2, label the selections in this row Truitt-2-1, Truitt-2-2, Truitt-2-3, etc., the second number in each case being the number of the individual selected in this generation, while the first number, 2, is the number of the original first generation selection. In the same way if progeny 51 is one of the best, the selections made from this would be numbered 51-1, 51-2, etc. When the third generation selections are made they may be numbered in the same way, separating the generation by a hyphen; for example, the selections made from progeny of 51-1 would be labeled 51-1-1, 51-1-2, 51-1-3, etc.

In case the breeder is working with a large number of varieties and making numerous experiments it is probable that the use of the name of the variety to distinguish the different experiments would grow cumbersome and under these conditions the writer would suggest that the different experiments be numbered, so that the selections of Truitt, for instance, might be 10 in the series of numbers, selections of Hawkins 11, and so on, giving a different serial number to each different series of experiments. This number of the experiment should then precede the number of the selections, being separated from the number of selections by a hyphen, as in the case of separation of generations. Following such a system as this the first number before the hyphen would always represent the experiment number or series number and stand in the place of the name of the variety in the system described above. It is probable, however, that the use of the name of the variety and not the serial number is the simplest method where breeders are working in a practical way with only comparatively few varieties.

SECURING SELECTED SEED FOR GENERAL PLANTING OR FOR SALE.

To secure selected seed for planting a general crop probably the most satisfactory method all around in cotton is to take practically all of the seed from the breeding patch after the selections have been

picked, and use this to plant a multiplication plat. Even in this case, however, the writer would urge that a certain amount of selection be practiced. He would advise that growers and breeders take special cotton pickers and train them to recognize a good productive plant; then after having selected and marked the best plants in the breeding patch send these pickers over the breeding patch, instructing them to pick all of the seed from the productive plants that are not marked as specially selected. The seed thus obtained, which is in itself selected seed, can be used to plant a multiplication plat. The seed taken from the breeding plat in this way the writer has always in his experiments designated as "breeding plat seed." The breeding-plat seed obtained in this way is the next year planted in a multiplication plat, and usually a sufficient amount of seed will be obtained to plant a field of considerable size. If there are 100 selected plants in the breeding plat, enough good seed (breeding-plat seed) should be obtained to plant a multiplication plat of at least 10 acres, if the seed is used judiciously. When the multiplication plat matures and is ready to pick, the trained pickers should be sent over this plat with instructions to pick the seed only from the best plants, as above described, and this seed may be designated as "*multiplication-plat seed.*" This seed the ensuing year will plant a very large area and furnish a considerable quantity of seed.

If the breeder is breeding cotton simply for his own use, it is probable that the seed from this general crop would not be utilized for further planting. If, however, he is breeding seed for sale the general crop seed is the seed which would ordinarily be placed on sale. In the case of the cornbreeders, the specially bred pedigree seed which is ordinarily distributed is seed taken from a general crop but the ears sent out are selected ears, all of the seed, of course, having descended from original selections through the breeding-patch and multiplication-plat, as in the method outlined above. In the case of cotton it is impossible, of course, for the breeder to select from this general crop in the same manner that the ears of corn are selected from the general crop of corn. However, the seed which is picked from the good plants by the trained pickers is equivalent to this ear selection in the case of corn and this seed would be the seed generally sold. In general terms we call this seed "selected-stock seed." In the case of corn, as is well known, when the selected ears from a general crop are exhausted, quantities of the ordinary ears are shelled and used for planting. In the case of cotton the remaining seed from the general field of cotton could be retained and sold simply as good seed of this variety and in this case the term "*general-stock seed*" could be utilized to designate it.

CONTINUING THE SELECTION IN THE THIRD AND LATER GENERATIONS.

In the third year, the individual selections made the second year should be planted in a special breeding plat, such as described for planting the first-year selections. The planting should be made in the same manner, using the plant-to-row method. The individual selec-

tions should be made in the same way as in the first and second years, when the progenies of the second-year selections have reached fruiting condition. In succeeding years the same methods of selecting the best individuals and testing them the ensuing year should be pursued, forming, as will be seen, a continuous method of pedigree selection.

Each year also, second choice seed should be taken from the breeding patch to furnish seed to plant a multiplication plat from which in turn choice seed can be taken to plant a general crop.

SCORE CARDS AND THEIR USE.

In carrying out such a system of systematic selection as that outlined above, the breeder will find it very desirable and convenient to use a score card in judging the different individuals and this, furthermore, facilitates the keeping of records. In judging ordinary short-staple cotton the writer would suggest the following score card which may be modified to suit special conditions:

Scheme for a score card for judging cotton.

Character of plant—10 points.		Length of lint—10 points.	
Excellent	10	1¼ inch	10
Good	8	1 1/16 inch	8
Fair	5	1 inch	6
Poor	2	¾ inch	2
Earliness—15 points.		**Lint quality and strength—10 points.**	
Very early	15	Excellent	10
Early	12	Good	8
Medium early	8	Fair	5
Late	2	Poor	2
Size of boll—10 points.		**Yield of seed cotton—20 points.**	
Very large	10	Excellent	20
Large	8	Good	18
Medium large	5	Medium	15
Small	2	Light medium	10
		Light	5
Opening of boll—10 points.		**Per cent of lint—15 points.**	
Very good	10	38 15	32 8
Good	8	37 14	31 7
Fair	5	36 13	30 6
Poor	2	35 12	29 5
		34 11	28 4
		33 10	

In the above scheme for a score card practically all of the important points, it is believed, are mentioned unless one is breeding to secure some special quality or character. No lint yield is included as such, because this is practically recorded in the score on yield of seed cotton and per cent of lint. All of these characters should be reduced to

measurable quantities, as far as possible, to avoid errors of judgment. Under "earliness" one can set a date, as for instance, September 15, or October 1, and judge the degree of earliness by the actual per cent of the seed cotton which is picked by that date, determined, of course, by actual weight of the seed cotton. In "size of boll," "length of lint," "yield of seed cotton," and "per cent of lint," all of the figures can be determined by actual measurement or weight, so that the variations in individual judgment can be reduced to a minimum. The size of the boll can be measured by calipers or better still, by weighing the product of 5 average bolls and getting the average weight of seed cotton per boll. The lint can be combed and measured. The total product of seed cotton produced per plant can be weighed. The lint or seed after ginning can be weighed and the percentage of lint determined.

The following is a contribution to this report by R. L. Bennett, College Station, Texas.

METHOD OF COTTON BREEDING FOR EARLINESS AND PRODUCTIVENESS.

The method for cotton breeding for earliness and productiveness that has been worked out from the cotton breeding investigations, of which I have had charge in Texas for the United States Department of Agriculture and the Texas Experiment Station, is stated in brief below.

I have sought to get earliness and productiveness by selection, and I have found that there is sufficient variation in American upland cotton for selection to develop cotton superior in earliness and productiveness to varieties now in cultivation.

Certain factors reported in this method of breeding cotton by selection have a dependence on the vegetative and reproductive processes in their relation and effect on each other. These factors and the influence of environment will be discussed in a future bulletin or report when experiments that are in progress are completed. Selections made according to this method of breeding showed in the past year superior earliness and productiveness in comparison with standard early varieties of cotton.

The principles governing selections for several purposes are given below.

For early and rapid fruiting and maturing cotton:

1. The first fruit limb must be low, not higher than the fifth or sixth joint above the seed-leaf joint.

2. Primary or wood limbs must be low, the first not higher than the fifth or sixth joint above seed-leaf joint, and it is desirable that they do not exceed 4 in number.

3. The joints on the main stem, fruit limbs, and primary limbs must be short.

4. Fruit limbs should grow successively at the joints of both the main stem and primary limbs.

5. Fruit limbs should be continuous in growth for continuous fruiting until the plant is matured.

For productiveness:

6. The bolls should not be less than one and one-half inches in diameter and one and one-half inches in length inside.

7. The proportion of lint to seed cotton should not be less than 33⅓ per cent, and as much more as possible.

For storm resistance:

8. The hull or burr should be thick, so as to retain its edges opposite to each other when open.

REPORT OF THE COMMITTEE ON BREEDING NUT AND OTHER FOREST TREES.

By GEO. B. SUDWORTH, *Forest Service*, and Dr. A. D. HOPKINS, *Bureau of Entomology, U. S. Department of Agriculture.*

Having made a preliminary inquiry into the subject, it is found that very little has been attempted, and practically nothing has been accomplished in the selection and breeding of better forms, varieties, or species of the commercial trees. Early use of our natural forests has been very largely through continued culling or complete cutting of the best individuals, with little or no refernce to improving or perpetuating them or of improving their quality. This has no reference to the direct or indirect bearing upon such improvement as the aims and practice of technical forestry have, through special silvicultural measures, in maintaining and in improving the inherent commercial qualities of timber species.

Considerable has been accomplished by artificial selection and propagation of natural varieties and hybrids of tree species, other than fruit-bearing kinds, for ornament and shade. These demonstrations show clearly the wide range of departure possible from normal types. Very considerable has also been accomplished in the improvement of certain nut trees for the commercial and domestic production of their fruits. Nothing appears to have been done toward the improvement in the same individual trees of the commercial qualities of both fruit and wood. This, however, seems an undesirable, if not an impossible combination, for the reason that fruit production of the highest efficiency demands of the tree a form development unfavorable to the production of the best timber form.

Attention has been called to the possibilities of breeding forms or varieties of trees which would be more resistant to or even immune from their present insect enemies and diseases. On this line a beginning has been made towards the discovery and propagation of a form of black locust resistant to borers. Attempts are reported also as being under way to breed the forms of maple, walnut, and other species which have curly or variegated woods. The constant demand and high

prices such woods command have stimulated investigation along this line. There has also been reported recently a line of experiments in the breeding of a form of sugar maple which will yield highly saccharine sap.

The committee is impressed with the possibilities of improvement in nut and other forest trees, comparable with what has been accomplished with cultivated plants and domesticated animals. Trees do not differ essentially from other plants or from animals in their response to such treatment and conditions as tend to produce variations and forms which are most useful to man. It is believed, therefore, that with the modern knowledge of breeding as a basis for the development of methods specially applicable in the breeding of forest trees, we are likely to obtain improvement in the matured tree or forest of the future. Under the head, therefore, of general principles, ways, means, and methods, the following very tentative suggestions for immediate application by plant breeders, foresters, nurserymen, or other practical growers, are submitted:

1. Seeds should be selected from the best individual representatives of a species growing under climatic and other conditions similar to those of the localities in which the seeds are to be planted. Seed from individuals in colder parts of the species' range are likely to give more thrifty plants in a warmer part of the range, than if obtained from a warmer part and planted in a colder climate.

(*a*) Therefore, seed trees left in cut-over areas should represent the best types of the species.

(*b*) The characteristics of the most desirable types of parent trees of a species should be studied in order to identify seedlings and saplings of the same or similar type to be left in thinning operations. Some of the special characters to be compared in parent and progeny in this work are the peculiarities of the first leaves, especially on sprouts, and particularly the dates on which they appear; also, the time of flowering, maturing of fruit, and of the fading, coloring, and falling of the leaves.

2. Special search should be made for natural forms, varieties, or hybrids possessing characteristics which will meet the requirements in different localities or regions, such as rapid growth, immunity from or resistance to injury by insects, disease, frost, drought, or excessive moisture. Whenever such ideal examples are found, they should be used as stocks from which to propagate. Such stock should be propagated asexually, if practicable, and also by seed; reproduction by the latter method should be used to determine the relative number of seedlings possessing desirable parent characteristics.

There is probably much of interest and value to be accomplished by better methods of cross fertilization, as also in the production of new hybrids from which to select types for further improvement through systematic breeding. But the long period required for obtaining comparative results from such experiments, suggests for most species the

desirability, if not greater importance, of beginning with the simpler methods of seed and seedling selection outlined above, which are available alike to the professional plant breeder and the practical grower. While many very desirable studies of the hereditary tendencies of development in nut and other forest trees would require too long periods for present purposes, many related subjects can be investigated, and results obtained within a reasonable time and without large expense, by being conducted in connection with general nursery and forest planting. The following suggestions are offered for such investigations:

(1) Testing the capacity of certain individuals of a species in producing seed from which choice young stock may be raised, thus establishing the breeding value of trees from which seeds may be gathered for future planting.

(2) A study of whether certain species are being self-fertilized or cross-fertilized; of whether, if cross-fertilized, it is by closely related or unrelated strains of the species. The disadvantages of close breeding in tree plantations, thus producing undesirable seed, may be determined and avoided by mixing unrelated strains of the species to be represented.

(3) Testing exhaustively the value of different trees of a species, which may be reproduced by cuttings, by growing clonal centgeners from each parent tree to determine from which stock clonal varieties of the greatest value can be produced.

(4) Testing the values of large numbers of parent trees of a species by growing from each seminal centgeners to determine from which to produce stocks both in self-pollinated species and in cross-pollinated species.

(5) Determining what species may be hybridized, recording the new values promised in each hybrid, noting the practicability of reproducing the progeny, whether from single mother plants in clonal or self-pollinated species or from groups of hybrid plants in cross-pollinated species.

(6) Devising the best methods of breeding important species of nut and other forest trees, under different soil and climatic conditions of obtaining different commercial qualities; the purpose of such work to be the giving of instructions to those desiring advice on the breeding of tree species.

(7) Securing the cooperation of all State and Federal offices, experiment stations, forest and other schools, or agencies interested in the improvement of forest and nut products.

It should be stated that the foregoing suggestions were very hastily thought out, and, therefore, probably do not logically or by any means fully cover the possible field of investigation which may be opened up by later careful and broader consideration of both the needs of improvement in the qualities of nut and other forest trees and of the range of variation possible among such plants. In view of this fact it is recommended that a standing committee of the Association be appointed to further consider and to promote work on the breeding of nut and other forest trees.

The following statements by Prof. J. Russell Smith, of Philadelphia; Prof. J. W. Toumey, of the Yale Forest School; and Dr. Hermann von Schrenk, of St. Louis, Mo., are made a part of this report.

STATEMENT OF PROF. J. RUSSELL SMITH, OF PHILADELPHIA, PA.

IMPROVEMENT OF FOREST TREES.

In these days of intense activity in plant breeding, one might suppose that forestry literature would give due weight to the subject of tree breeding, but the most progressive foresters do not seem to have recognized that there is a great field for the producer or discoverer of improved varieties of forest trees. The long time required for the maturity of a saw log is no doubt the chief reason why foresters have ignored this usually fascinating field. The patient, painstaking plant breeder may render a future valuable service to mankind by devoting part of his attention to forest trees.

It is a well known fact that individual differences are as marked among forest trees as among other plants. Undesirable qualities, such as twisted grain, thick sap, and tendency to heart-rot, are probably transmitted to offspring, while those qualities that go to make up an ideal tree from the lumberman's standpoint are also probably transmitted. The task of the forest-plant breeder is to separate the individuals possessing desirable qualities from those possessing undesirable and to reproduce only the former. The distinction of desirable qualities among forest trees will call for the highest type of ability on the part of the breeder. It is a well known fact that the uneducated woodsman distinguishes qualities of timber that botanical classification does not explain. It is just such qualities that the forest-tree breeder must learn to distinguish.

In the mountainous sections of West Virginia, the lumbermen recognize two types of the tulip tree; namely, yellow poplar and white poplar. The botanist will tell you that the white variety is simply a young tree in which the valuable heartwood has not been developed. The woodsman knows better, because he can point out old and young yellow poplar trees and old and young white poplar trees. He distinguishes the trees by the bark, and knows that the yellow-hearted variety is twice as valuable as the white.

The same distinction is made by the lumberman of the western river bottoms in handling the cottonwood. Valuable yellow cottonwood grows alongside of inferior white cottonwood, but the botanist calls them both *Populus deltoides*.

In the southern swamps, the red gum grows with the white gum, both types of the sweet gum being called by the same scientific name.

Instances similar to the above could be multiplied almost indefinitely for there is scarcely a timber tree known to the lumber trade that does not furnish several different qualities of lumber recognized by the expert woodsman alone.

When our scientific foresters learn to give more weight to the practical knowledge of the wood chopper, there will be no reason why the propagation of the desirable types of any species might not be favored, and the reproduction of inferior types hindered.

It seems to the writer that the time will come when burly walnut, bird's eye maple, and curly mahogany will be propagated at the will of the forester.

IMPROVING THE VARIETIES OF CULTIVATED NUTS.

The most important possessions of the human race are the cultivated plants which from prehistoric times man has kept and gradually improved until now we have in them the basis upon which our civilization rests, even more absolutely than it does upon the steam engine, the railway, and the printing press.

This plant improvement has gone on for ages in the hit or miss fashion of unscientific, but patient endeavor, until at the present period we are in possession of knowledge whereby we can accelerate one-hundred-fold the age-long process of making ourselves new riches from new plants. In no part of the vegetable kingdom is there greater promise than among those plants which yield us useful nuts, and in few, if any, of the now useful plants is there so great prospect of profound and revolutionary improvement. A host of wild products that have been used by man and wild animals for ages have, because of the resistance to the old method of improvement, remained absolutely undeveloped. Now we know how and are ready to begin the great march if a limited amount of means and a large amount of patience can be forthcoming to promote the work.

The nuts have very great food value which the students of cookery and nutrition are just beginning to appreciate. They have so far not been used to any extent in this country, and the chief reason is that we have had abundant supplies of meats for which the nuts are substitutes. We are now, with our large population and the diminishing size of our average farm, entering upon an apparently unending epoch of high-priced meats. The nuts are substitutes to which we can turn for a satisfactory and available substitute for this want. The nuts have a particular advantage in this respect because by this means we get human food more directly. When we get it in the form of meat we get it indirectly: First, we raise the crop; then we feed it to the animal, and later we eat the animal, after it has wasted most of the food in maintaining its own physical existence and producing the waste parts of its carcass. A man who raises nuts can eat his product without having most of it wasted by putting it through these intermediate stages, and the population that a given area of land can support is much greater.

The chestnut, which is a very large factor in the food supply of the people in some parts of southern Europe, offers a most inviting field to the plant improver. We have Japanese varieties of chestnuts which actually equal or exceed the largest horse chestnut in size. The trees have vigor and disease-resisting power far exceeding those of our own native chestnut. They are exceedingly productive and precocious in bearing, and yet almost without exception the nuts are undesirable; some of them are so worthless that a well-bred American hog will let

them lie on the ground from September to Christmas. As a counterpart of this importation, possessing all virtues except good quality, we have the native American chestnut, which grows on the rockiest hillsides over a wide expanse of country on otherwise useless land, and has everywhere a much appreciated sweet flavor; yet its small size greatly reduces its value as an article of human food. It would appear to be a simple task for the hybridizer to blend these strains and receive as a result a marketable nut, possessing all desirable qualities.

The walnut offers a similarly inviting field of endeavor. We have the American black walnut which thrives over a vast extent of our country, almost, indeed, from Maine to the Great Plains, and from the Great Lakes to the Gulf. It is a nut of good quality and is appreciated by many of our people; by some it is even set above the Persian (or so-called English) walnut, now extensively grown in Europe and California. Yet the unsightly, black and rough appearance of the black walnut combined with its thick, horny shell make it undesirable as a table nut, and also make it impossible to get the kernels out in satisfactorily large pieces. The Persian walnut grows to some extent in the East, but it is not hardy and it is everywhere subject more or less to crop destruction and even tree destruction, owing to our changeable spring and winter climate, although occasional trees seem to give the lie to the statement. I believe it is a fact that there is no successful large orchard of these nuts east of the Mississippi river, and to my certain knowledge, failures have been rather numerous.

The Japanese walnut is perfectly hardy in eastern United States, and while the fruit is of little value, it is a tree of astonishingly vigorous growth. These three nuts, the Persian, the Japanese, and the native American, readily cross-fertilize. Here, therefore, is another problem whose solution appears to be a matter of time, patience, and work; in the end we should have a walnut for Pennsylvania and New York which is in every respect as good as the profitable Persian walnut of California.

Among the hickories, the pecan problem has been practically solved, and the production of these nuts has rapidly become an industry in the South. The northern shellbark, a native of the North Atlantic and Central States, possesses a very acceptable quality and is much prized, and it can by care probably be made to do for the North what the pecan is doing for the South and Southwest, especially as it is possible to cross-fertilize the pecan and the shellbark.

The trouble with all these problems of nut evolution is that they require time, usually several years, to see the results of a single experiment, and, therefore, it is only to be done by an individual who works for pleasure or for governments which are willing to spend money without the certainty of results at any particular time; yet there is no sphere of human activity in which the government can more readily promote economic progress than by the search for and the improvement of plants upon which our whole agricultural industry after all depends.

The tree industries, and particularly the nut industries, should be of especial interest and importance in the hilly parts of our country. Science has replaced most of our resources by some new discovery, but there is nothing to replace the land. It is the only irreplaceable resource, and we have lost hundreds and thousands of square miles of our land through the fact that hills too steep for tillage have been cleared, cultivated and washed away in the process. Instead of giving a meager return from grain raising, these hills might in the production of nuts yield a constant and satisfactory return with much less labor and give to our increasing population a cheaper, more satisfactory, and probably a more wholesome supply of the necessary nitrogenous foods upon which the bone and muscle of the land depend. It is doubtful if any part of the plant breeder's work is so well calculated to make the eastern waste places blossom and yield a harvest. It is earnestly to be hoped that the States or the Department of Agriculture can take steps to promote this work at an early date.

STATEMENT OF PROF. J. W. TOUMEY, YALE FOREST SCHOOL, NEW HAVEN, CONN.

The only suggestion which I have to make and the one which is most closely identified with my work in forestry is the value of seed selection on the character of the timber grown. It is well known from Dr. Hartig's work that heavy large seeds of forest trees when planted with smaller ones always produce the most vigorous plants and become the dominant trees in the ultimate stand. In some experimental work done by me a few years ago I found that it is probable that twist in trees is an inherent defect inherited from the parent tree. I planted a large number of seeds of the western yellow pine collected in the San Bernardino Mountains from the trees having an excessive amount of twist in the grain. As you probably know, this renders the timber of little structural value. I found that when these seeds were planted here in the seed beds in New Haven, even the first year a large number of the seedlings exhibited this same characteristic and I have no doubt that if these trees were permitted to develop, they would all have twisted fiber.

I believe that if experimental work were done on the selection of seeds, giving particular attention to the question of size and quality it would be of large importance. I also believe that if a study were made in the selection of seeds from trees showing various types of inherent defects, such as the one mentioned above, interesting results would follow.

STATEMENT OE DR. HERMANN VON SCHRENCK, MISSOURI BOTANICAL GARDENS, ST. LOUIS, MO.

There is submitted herewith, for the information of the committee, certain abstracts which I have made of the more recent works. Referring to the problems at hand, I may review the same briefly as follows:

I have no doubt whatever that the selection of seed for forest-tree propagation is a desirable thing. This selection will involve several factors, such as selection for wood production, greater adaptation to a specific climate with highest physiological development, selection for disease-resistance, etc. I think we may start out with the assumption that selection for wood production will be attended with very poor results, except where such selection is made to develop forest growth in the same region as that in which the parent tree from which seeds are collected grows; in other words, I think there is no doubt whatever that environmental conditions which surround the new plant have far more influence on the rate of growth in the long run than any hereditary influences which might be transmitted through the seed. I fully believe that there is a very vital field for selection in the matter of disease resistance. We are now working on the problem of the damping-off disease of coniferous trees, for instance. Seedlings of these species may be considered unsafe until at least the third year. We are working to find races or varieties, if such exist, of the various species which have a sufficiently rapid rate of growth during the first two years, or which form sufficient protective bark, or which develop antiseptic qualities to make the trees fairly safe from the time the seeds germinate. I would call particular attention to the result noted in one of the papers which I am sending, in which it was found that "Schutte" disease (*Hysterium pinastri*) killed all of the young Scotch pines grown in France during one year except those taken from a specific region. There are numerous other instances of disease resistance which have been noted from time to time, and I see no reason why we should not be as successful in finding disease resistance, providing care is given to seed selection, as we are with garden plants. I inaugurated some experiments last year, myself, to determine something as to the relation between the source of white pine seeds from various parts of the country and the rate of growth obtained when such seeds are sown in other geographical regions. It is too early as yet to give any results from this experiment. I have this year extended the work to oaks.

It seems to me that a carefully formulated series of experiments might very easily be undertaken both with forest and nut trees, to answer a number of specific problems. Among these occur to me the following:

(1) Influence on subsequent growth of the size and weight of the seeds, all being taken from one tree.

(2) The same problem relating to influence of size and weight of seeds from different trees of the same locality. In other words, will a seed weighing 5 grams from one tree give the same subsequent growth as the seed weighing 5 grams from another tree, when grown under the same conditions as the first one.

(3) Influence of locality of collection on subsequent growth, when planted in different regions.

(4) Influence of selection on subsequent development, when grown in the same region as the parent tree, i. e., under similar environmental conditions.

(5) The effect of selection to determine whether there are distinct races of the various species.

(6) Should such races be found, are they any more or less resistant to various types of disease.

During the coming year I will attend to this matter with more vigor, and will be glad to carry out any suggestion which the committee may assign.

The following are the abstracts referred to:

Experiments made to determine the importance of the origin of the seed of *Pinus sylvestris*.*

The writer states that the superiority of certain plants obtained from a definite locality may only be in one direction. The more rapid growth of early life may be counterbalanced by such factors as straightness, density of the wood, etc., which may compensate or even surpass the advantage obtained from rapid growth.

A description is given of the first experiments in selecting seeds made in April, 1902, in which experiments seeds from 10 different points in Europe were planted. The interesting result was found in 1903 that the young plants were all attacked by the "Schutte" disease—*Hysterium pinastri*, with the exception of all the pines from the d'ecosse region. The same immunity of these trees was noted in another pinery in the forest of Soignes. If the further experiences with this race should bear out this first finding it would show a notable advantage for this variety.

In 1904 an examination of the trees was again made; the most interesting comparison lies in the trees obtained from seeds selected from stunted trees, and from vigorous trees of the same locality, namely, Campine. The seedlings from the stunted trees showed a growth of 24 c. m., while those from the vigorous trees showed a growth of only 22 c. m. This seems to bear out the observations made by Hartig, who maintained that one could grow trees from seeds selected from stunted trees just as well as from vigorous trees. This opinion of Hartig's is, however, not a universal one, as indicated by the views of Kirwan, who refers to a region in Lozère, where a race of *P. sylvestris* has been growing for many years, subject to violent wind-storms, very poor soil, etc., as a result of which, all of the trees are much stunted and dwarfed. In the years 1878-1885 a large number of acres were planted in the department of Gard with seeds from these stunted trees. The plantations are 20 to 25 years old now, and all of the trees show a very much stunted character, with twisted trunks, short branches, precocious fructification, and very small cones. Kirwan states that if the nature of the soil in which the seeds were grown were the sole factor to be considered, the seeds from these twisted pines, if sown in a very much more favorable country, should have given well-formed and vigorous trees; but this did not happen. He concludes from this that one should select seeds from the very best trees. This is frequently not done, because, in case of the pine, the seed collectors can more easily get seeds from stunted and twisted trees than from tall straight ones. He recommends a careful supervision of the seed collectors in order that they may get seeds only from the largest trees. In discussing the views of Kirwan the writer of the present paper states a fact, which seems to be established once again by the experiences just noted, that the seeds collected from trees of high altitudes give trees which are less vigorous than those from seed collected on the plain.

* Nypels: La Selection forestiere et la provenance des graines. (Bull. de la Soc. Cent. Forest. de Belgique, 12: 705, 1905.)

Engler * investigated the influence of the following factors relating to seed selection:

1. Origin of the seed.
2. Character of the seed.
3. Effect of the source of the seed on the growth of the plants, including height and volume growth, influence of the size of seed on the growth of spruce, and yearly increment of growth in height.
4. Influence of the seed on morphological and anatomical characters of the plants.
5. Resistance towards climatic influences of trees grown from seed obtained at different altitudes.

His results may be brought together briefly as follows:

1. The weight of the seed and the germinating capacity of spruce seed become less as the elevation of the parent trees increases. Large seeds give larger and better plants, and the rate of growth is directly dependent on the source of the seed. The adaptation of the physiological processes to different temperatures is hereditary; the thick bark of the highland spruces is found in the young plants.

2. The view which is sometimes held that straight-boled good trees can be grown only from seeds obtained from trees having the largest and most perfectly formed trunks is erroneous. A stunted or diseased condition caused by external influences is not hereditary.

3. The fir is morphologically constant, and does not split up into physiological races, as does the spruce. The fir acquires no characters in high altitudes which are hereditary. The larch has two climatic races. The mountain maple can adapt itself to the climate, and this adaptation is hereditary. Trees coming from high altitudes remain dormant for a longer period than those from low altitudes.

Gayer (Der Waldbau, 1898, p. 290) says: "It is not to be denied that the individuality of each plant is to be carried back primarily to the seed. If we were to select seeds from vigorous trees which show maximum growth, and carry on seed selection in the same manner as is done in growing garden plants, a splendid result would probably be obtained." He recommends the selection of seed according to size and weight, stating that the largest and heaviest seeds are always to be given preference over smaller and lighter seeds. He states that the superiority of the plants which grow from large heavy seeds, compared with those from smaller seeds, can be detected for a large number of years, and that the plants from the heavier seeds are the ones which form the stands of the new forest. He says: "Concerning the influence which the origin of the seeds has on their quality, very little is known; it is certainly true that well-grown, large, and open-crowned trees gives the best seed; but with many kinds of wood, the seed which is collected from younger trees, and in other cases, from very old trees, is likewise good seed. It cannot be doubted that the influence of the particular environment, and especially the climatic conditions in which the seed trees grow are of greater importance than age of the seed tree."

He refers farther on to the question of adaptation which plants have acquired in the course of long generations, to the climate in which they are growing, and to the hereditary nature of certain growth phases which have resulted therefrom. "It is an undoubted fact that abnormal growth phases, such as reduction in resisting power to the environment and retrogressive changes, such as twisted form and stunted growth, take place. In such cases seeds should be selected from regions of similar climate to the ones where the new trees are to be grown.

* Engler, Arnold. (Mitteil. d. Schweiz. Centralanstalt f. d. forstliche Versuchswesen, 8: Heft, 1905.)

Cieslar * investigated the question—to what extent wood development and the form of growth in trees is hereditary. He starts with the assumption that, under the influence of climatic conditions, a species of tree develops certain physiological and morphological changes in the course of centuries; as the result of this, individuals of the same species, growing in the same regions, may come to have decidedly different properties; if these properties have become hereditary, they ought to show themselves when such trees are grown in places other than their native localities.

He collected a number of spruce seeds in 1892, from different points in the Alps, and at various points in Bohemia, Galatia, and south France. In the spring of 1893 he planted these seeds at Mariabrun and determined the height and volume of the resulting seedlings, in the fall of 1893 and 1894. He finds that the length of growth, as well as the volume of the 1-year-old plants checks with the height of the point of collection of the seed. He finds that there must be some hereditary influence, because the young plants in the mild climate of his experimental garden retained some of the distinctive growth features which had characterized parent plants in their native locality.

He finds in examining 8-year-old larch trees that there is a similar hereditary influence; the larch trees which came out of the mild climate of the Sudeten grew very much more rapidly in the first eight years than did those which came from the Tyrol.

Nyples † discusses the experiments of Cieslar and refers to the importance of a general investigation of the selection of forest seeds. He refers to the fact that mutilations are not hereditary, and after a general discussion reviews the experiments of Cieslar with spruce, quoting the following figures: In the third year the trees which came from seeds collected at high altitudes—of 325-630 meters—showed an average growth of 15½ centimeters. The plants which came from seeds of medium altitudes—about 1000 meters—showed a growth of 10.9 centimeters. Plants from seeds collected at high altitudes—1500 meters—made an average growth of 7.4 centimeters; and from altitudes of 1650-1750 meters showed a growth of 4.3 centimeters. Plants from Swedish showed an average growth of 2.2 centimeters. He quotes Cieslar's conclusions: That in the low and medium elevations the plantations are generally surrounded by weeds which enter into a dangerous competition with the young trees, especially if the ground has been in an unplanted condition before the tree seeds are planted; accordingly the trees which come from seeds grown in the northern climates or on high mountains should be rejected, because their rate of growth will not be fast enough to overcome the crowding of the weed plants; one should, on the other hand, choose seeds from which trees will grow rapidly. A second conclusion which he comes to is that one should always choose seeds coming from the same altitudes as those at which one wants to grow trees.

He discusses the experiments of Cieslar with larches, showing that the larch of the Alps and the larch of the Sudates form two distinct races, with hereditary characters, which they maintained under all situations when cultivated by Cieslar. He then goes on to discuss the result with *Pinus sylvestrisat*, one of the large centers of the production of pine seeds in Darmstadt. Among many foresters, the trees from which these seeds are collected have a very bad reputation, because they are said to be twisted and deformed, and not to give as straight trunks. On the other hand, the pines growing at Riga have been known for a long time for their straight trunks and excellent wood. According to Professor Mayr, this remarkable straightness of the Riga trees is not due to hereditary

* Die Erblichkeit des Zuwachsvermögens bei den Waldbaumm. Adolf Cieslar. Cent. f. d. gesam. Forstwesen, January, 1895.

† Nyples. La Seléction forestiere et la provenance des graines. Bull. de la Soc. Cent. Forest. de Belgique, 9: 61, 133, 1902.

factors, but due to various other causes, such as an even temperature and humidity of the atmosphere, there being really no essential difference between the pines of Riga and those of south Germany. The irregular growth and curvatures of the south German trees are to be explained by differences of the climate and soil, and to troubles incurred in the course of the growing period, such as wounds, etc.

Von Sievers is, however, of a totally different opinion; he says that the hereditary twisted growth of the Darmstadt pines has been demonstrated in practice, beyond question. He maintains that there is a characteristic difference in the two kinds of pine, and distinguishes between an inborn tendency to curvatures on the part of the pines of Darmstadt as distinguished from curvatures which are produced in the Baltic pines by snow and outer lesions. In fact, says von Sievers, all of the pines of Darmstadt planted in Lavonia are defective, even though in the best soil. The foresters of that region are absolutely convinced in this respect, and according to them, the pines of southwestern Germany have a hereditary tendency to become crooked. Von Sievers arrives at the same conclusion as that announcel by Cieslar, namely, the desirability of planting indigenous seed. Nypel says: "The bad condition of most of the pine plantations in many regions of Belgium is a fact which is often mentioned. According to the statements of many practical men, this lamentable situation is due principally to the poor choice of seed; for a hundred years, collections have regularly been made, of seeds from the most defective trees which had arrived at maturity prematurely; in fact, a continuous selection has been made that was in every sense unfavorable. If we do not decide to cease these ancient habits and give more attention to the careful selection of seeds, we will certainly bring about a race without value, a mediocre product, arriving at maturity and ceasing to grow long before a profitable exploitation becomes possible."

Kienitz and Schott made a report at the 7th meeting of the German foresters at Danzig, in which they presented a discussion on the importance of obtaining good seeds and plants for forest reproduction; they maintain that seeds must have a high germinating power, and that all seeds must come from parent sources growing in a climate similar to the one in which the seeds are to be sown. They make the statements, furthermore, that it is not always advisable to buy the cheapest seeds, because foreign seeds are cheaper than native seeds. The dealers get the seeds from small trees because these usually are not only easier to obtain, but bear heavily. They make the recommendation that seeds be obtained only from the best stands. Stubenrauch* discusses their recommendations at length, and agrees with them that it is not wise to buy the cheapest seeds. Ignoring for the moment the possibility of the degeneration of the parent trees, he questions whether the cones (and consequently the seeds) from small trees are as good as those from well-grown trees 50 to 80 years old. The latter are generally long and pointed, but have few seeds, which makes their collection more expensive; the cheapest seed is, therefore, not the best. Stubenrauch thinks that the recommendation that seed should always be taken from the best trees will not be practicable.

Note in this connection, also, a paper by Schotte—Ueber die Variation des schwedischen Kiefernzapfens und Kiefernsamens in Naturwiss. Zietsch. f. Land u. Forstwiss., January, 1906, p. 22.

Schlich's Manual of Forestry† referring to weight and size of seeds states that "in the case of one and the same species, all heavy seeds are better than light ones. The former generally possess a greater germi-

* Stubenrauch: Die Kiefernsamengewinnung (Zeit. f. Forst. u. Jagdwesen, 38: 802, 1906.)

† Vol. 2, p. 42, 1897.

nating power, and the resulting seedlings show a greater power of resistance against external injurious influences, and a more vigorous development, which in many species is due to the greater quantity of reserve materials deposited in the seed. This superiority at the first start should not be underestimated, because it is recognizable long after the seedling stage has been passed. In many cases the dominating trees grow out of seedlings which had the best start."

At another point in discussing the source of seed he says: "The source whence seed has been obtained is of importance. Although trees of all ages can yield excellent seed, as a general rule it may be said that the best seed is derived from trees which are in the prime of life, namely, healthy trees with a full crown, which have just completed their principal height growth. At the same time, soil and climate, especially the latter, are of greater importance than the age of the trees.

"The question has been raised whether it may be advantageous to obtain from time to time seed from another locality, as is done in agriculture. This may become desirable when the trees are affected by disease or by peculiarities which are transmitted through seed, as for instance, twisted fiber; apart from such cases, it is probably better not to change the seed. Trees live for a long space of time, and they accommodate themselves to a locality, so that home seed is likely to do best."

REPORT OF COMMITTEE ON BREEDING FORAGE PLANTS.

By Prof. J. H. SHEPPERD, *Fargo, N. Dak.*

As chairman of your committee on breeding forage plants, I wish to explain that the report which I submit herewith may not represent the ideas of the committee as a whole. There seemed to be a strong probability that a majority of the committee would be able to meet for a personal conference during the fall months and I delayed correspondence with the thought that I would be able to confer much more satisfactorily after the proposed meeting. Later on it was found impossible to effect a meeting of the committee, and, a number of unexpected duties falling to the lot of the chairman, he was unable to take up the matter with the members of the committee until so late a date that the final report as compiled could not be returned to them for revision, criticism, and sanction.

The more intense nursery method of breeding forage crops has not been generally taken up so promptly as the work with grains, although the worthy secretary of this organization spent considerable time and effort upon the timothy plant in a strictly nursery way nearly twenty years ago and left the writer a heritage in the form of a timothy plant nursery at Fargo in 1893.

Garton Brothers, of England, have for many years given to the world an example of successful work in nursery forage plant breeding.

American experiment stations have, however, worked out the preliminary and fundamental basis for nursery or individual plant work by studying cultural methods and the adaptation of standard and introduced sorts to particular districts. Cornell University Station, for example, has made a study of the relative production of the differ-

ent grasses, the relative palatability, the influence of mixtures in reducing the number of weeds, the influence of fertilizers and the development and duration of various species of grasses and clovers. The Cornell Station has carried on experiments to determine what is necessary to succeed with alfalfa on soil confessedly not adapted to this plant. They have learned that on Dunkirk clay loam three things are essential to successful alfalfa culture; manuring the land with stable manure, the application of lime, and the use of soil from other alfalfa fields. These experiments have shown that with this soil type, no two of the conditions named are sufficient for successful alfalfa culture. The above described trial is being followed by plant nursery work as a natural consequence, and, of course, with much better chance of success than though the preliminary work had not been done.

The work of the Northwestern State stations has dwelt much longer upon preliminary trials than is necessary in the older districts as the country is new and not adapted to the old line of cultivated strains. Ten years of work were necessary to learn the cultural requirements and natural adaptation of that peculiar but ultra-useful Plains plant, Brome grass, and much still remains to be done in that direction. The North Dakota Station has spent more than a decade upon a native forage plant—Slender Wheat Grass—(*Agropyron tenerum*) and has succeeded in adapting cultivation and farm handling methods to it in such form as to make it a standard grass for that section. All of this is preliminary and essential foundation work for plant breeding; and, while it is to be regretted that nursery-plant breeding was not carried on at the same time, let us congratulate ourselves upon the fact that the work has really been in progress much longer than we are frequently wont to reckon.

Forage-plant breeding resolves itself into six features or lines for experimentation.

1st. A study of the forage plants adapted to a given district and those which can be grown economically by the producer.

2d. The cultural methods adapted to each particular sort such as the best date and thickness of seeding, preparation of the seed bed, depth best adapted, the degree of success attained with and without a nurse crop, the supply of fertility and of humus required, and various features of alkalinity and bacterial inoculation. Many of these points are already known from the common experience of the forage producers of the district, but they prove serious and frequently thwart effort when not taken into account and worked out as fundamental and pre-requisite preliminary studies. Some most excellent native grasses of the Plains, for example, seed very sparingly, which makes the reproduction of them in a field way so expensive as to prove prohibitive to their use as cultivated crops.

3d. Plant nursery selection which ramifies into many details of work according to whether the individual plants are studied in detail as to the number of stools produced, diameter of the stems, number of

leaves per culm, flavor and odor, the chemical features, such as crude fiber when of pasture size and age, crude fiber when heading, when in blossom, when the bloom has fallen and when in the milk, dough, glazing, and ripe stages of the seed. In like manner the protein, nitrogen-free extract, and ether extract are features of interest and present useful fields for research work. After the successful strains are increased comes the question of the quantity of each refused by the different classes of live-stock and the composition of the part rejected.

4th. Cross fertilization presents a promising and fascinating field for operation among forage plants, giving wide variations in type, hardiness, quality and in fact in every useful feature. Now that vegetative reproduction is successfully practiced this field of work and that of hybridization are made much more probable producers of results than could otherwise have been expected.

5th. Hybridization is an almost wholly open field for work with forage plants and one which—reasoning upon principle and analogy—must prove of great service in producing the proverbial two blades of grass where one grew before.

6th. The production of hardy strains as measured (a) by wet swampy conditions; (b) by uniformly dry seasonal districts; (c) by climates subject to drought during certain portions of the season; (d) by the presence of alkali salts; (e) by other climatic conditions such as the degree of humidity of the air.

With all of these conditions and climatic helps the investigator can usually make rapid strides with introduced forage plants until approximate equilibrium is reached after which either an intense condition, such as strong alkalinity or the plant-breeding methods which induce variation must be relied upon for still further improvement.

In the last two or three years important results have been obtained by a number of experimenters—the following being some which have come under the immediate observation of one of the members of your committee: (1) Results from work upon timothy by Hopkins in West Virginia; (2) with certain grasses by Burbank in California; (3) with a series of leguminous forage plants and grasses by W. A. Wheeler in South Dakota; and (4) with sorghum varieties in northern Texas by A. H. Leidigh, and A. B. Conner, of the Bureau of Plant Industry. This probably represents a mere fraction of the work carried out by all investigators with forage crops.

Methods of breeding are not yet as highly developed as in the case of such staple crops as wheat, corn, and cotton; and the problem of determining which are the best individual plants of alfalfa, red clover, or timothy, for example, is not always an easy one. Judging the value of variations in these crops is by no means a simple matter, for the characteristics of individuals have not been studied as closely as in other crop plants. Simple selection has so far been the method principally followed in this country, although the striking results with cowpeas and other forage plants recently obtained by Oliver, of the Bureau of Plant Industry, show what can be obtained by judicious crossing.

The methods do not differ in any important respect from those followed with most field crops. The first selections can be made from such fields of the crop in hand as the breeder finds in his neighborhood, or from small plats that have been seeded for the purpose. The former method is probably preferable in most cases, as a larger number of plants are available and there is a better chance of securing hardy individuals, capable of good development under more or less unfavorable conditions. In whatever way obtained, the seed of the selected plants of each strain or variety is then to be sown in small breeding plats, the progeny of each individual being given a separate row or fraction of a row. The plats should, of course, be as uniform as possible with regard to soil texture, drainage, etc., in order that variations due to differences in the environment may be as far as possible eliminated. What we should have is, of course, a perfectly fair comparison of the individual plants and this can only be had by perfect uniformity of the conditions. In the case of most forage crops it is necessary to thin out the rows after the seedlings are up, so as to leave room for each plant to attain its full development without being crowded. This is especially important where free stooling is desired or where capacity for seed production is given especial attention. It should be remembered, however, that the progeny of individuals that are best and most productive under these experimental conditions will not necessarily give the largest yields when sown in the field under ordinary cultural conditions. The final test of any strain thus obtained must be its performance when grown in the usual manner.

Where rapid propagation from one or a few selected individuals is desirable, the method followed by Hopkins with timothy, that of transplanting rooted suckers from the parent, is to be recommended, when working with grasses that have the habit of stooling. Oliver has recently perfected a method of vegetative propagation of forage crops which consists in cutting off the upper part of the stem and rooting it in sand. In this way he has been able in one season to secure thousands of thrifty individuals from a single plant of alfalfa. Mr. Oliver believes that this method can be used with all herbaceous dicotyledons. With monocotyledons it is less satisfactory, although good results have been attained in rooting the young leafy shoots of oats.

Where resistance to cold, drought, alkali, or disease is the main object, nature cooperates with the breeder to the extent of doing a large part of his work and it becomes necessary to select only the best of such plants as survive these strenuous conditions. In such cases the breeder is generally well pleased to obtain a strain of only fair quality and productiveness, provided it is strikingly resistant. But where the conditions are entirely favorable to the crop and it is simply a question of securing an improvement in yield or quality much closer attention to the individual characters and greater degree of judgment are demanded. Careful counts of the number of stalks, number of leaves to the stalk, height, size and texture of leaves, etc., as well as careful weighings of green and dry yields are in order. Comparative chemi-

cal analyses and feeding tests are also desirable, before the strain is offered to the public. Little attention has been paid to the comparative composition and feeding value of slightly different strains of the same forage crop, but there is good reason to believe that this side of the work should not be neglected.

Mr. Kearney, a member of this committee, has had in charge for some years, the work of the Department of Agriculture in testing crops with regard to their resistance to alkali, with a view to securing useful plants that can be grown on the large bodies of alkali soil that occur in the Western States. Resistant plants have been sought, not only in this country, but in other parts of the world. Especial attention has been paid to alfalfa and other forage crops and it has been found that great differences exist in the ability to withstand alkali, not only between different species or varieties, but between different individuals of the same species or variety, some being able to ripen seed in three or four times as much alkali as others can endure. Carefully selected pieces of alkali land are used as breeding plats and the usual breeding methods are followed. Heretofore great difficulty has been encountered in the selection of land for this purpose, since the amount of alkali fluctuates greatly during the season, following the movements of the soil water. This difficulty is, however, being overcome with experience. During the coming season work of this nature will be carried on at North Platte, Nebraska (in cooperation with the State Experiment Station), at Fallon, Nevada, and at Yuma, Arizona.

REPORT OF COMMITTEE ON BREEDING BEES AND OTHER INSECTS.

By Dr. L. O. Howard, *Chairman, Bureau of Entomology, U. S. Department of Agriculture.*

The work of this committee during the past year has been necessarily limited. The attention of bee keepers has been called to the Association through the agricultural press in articles by two members of the committee and by references to it in addresses to various bee keepers' societies by Dr. E. F. Phillips, of the Bureau of Entomology.

Since the principles involved in breeding bees for improvement are practically the same as those employed by other breeders, it has seemed best, as a preliminary step, to call the attention of the persons interested in bee breeding to what has been accomplished in other lines of work. In addition to this, several cases have come to the notice of the committee where some peculiar results have been obtained and an effort is being made to find out the means employed. Attention will be called to this at a future time.

Mr. J. P. Moore, of Morgan, Ky., a member of this committee, and

one of the prominent queen bee breeders of the United States, has submitted the following which is an excellent outline of work:

To obtain the best results in breeding bees for improvement, drones as well as queens, should be bred from superior stock. The quality of the worker progeny of a queen largely depends on the quality of the drone with which she mates; therefore, the queen breeder who desires to make the greatest progress possible along the line of improvement, must exercise the same care in selecting drone mothers as he does in selecting queen mothers.

By having thousands of drones reared from excellent honey-gathering stock and keeping them in queenless colonies, we can be relatively sure our queens will be properly mated. In this locality (Morgan, Ky.), the bees destroy the drones after the main honey-flow is over, which is in the forepart of July, and we are compelled to keep drones in queenless colonies, otherwise we should not have sufficient drones to fertilize the young queens. By so doing and by giving our neighbors queens of our best stock, our queens do not have much opportunity to meet with any other than drones of good stock.

Since the bees which produce the most surplus honey are the ones which yield the greatest profit to their owner, I should place honey-gathering as the first quality to be considered in selecting a breeding queen.

Equally important also is prolificness, for without strong colonies when the fields are white with bloom, we cannot hope to obtain much surplus honey. It is quite evident that, other things being equal, the bee having the longest tongue will secure the most nectar, on account of its ability to reach deeper into the flower. Therefore, tongue-length is a point which the breeder cannot afford to overlook. Hardiness is another point to consider. We must have hardy bees so that they can endure long flights for nectar, withstand the cold of winter, and not succumb to spring dwindling. Gentleness is also a desirable point for we want bees that can be handled easily.

The ideal breeding queen then is one that is exceedingly prolific and produces bees with long tongues having the following qualities in high degree: honey-gathering ability, hardiness, and gentleness.

The method of rearing queens also has a great effect on their qualities, especially prolificness, and without that quality the others do not amount to much. To produce strong, prolific queens, the cells must be built in full colonies, well supplied with young bees. There is no colony better for this purpose than a colony which is about to supersede its queen, to which frames of hatching brood are added from time to time, thus keeping up the number of nurse bees in the colony. Such a colony builds fine, large cells and feeds the queen larvæ large quantities of royal food. . . . . Small, well-fed larvæ should always be used for starting queen cells. I prefer those about 24 hours old.

Whenever there is a scarcity of nectar, the cell-building colonies should be fed liberally. The colonies containing breeding queens should also be fed in such a case, in order to get well-fed larvæ for starting queen cells.

REPORT OF COMMITTEE ON COOPERATIVE WORK IN PLANT BREEDING.

By Dr. ALBERT F. WOODS, *U. S. Department of Agriculture.*

Your Committee on Cooperative Work in Plant Breeding begs to submit the following brief report:

The work at present under consideration by the committee is as follows:

(1) Cooperative work between the State stations and the United States Department of Agriculture, to be discussed by the Chairman.

(2) Cooperation in the improvement of orchard fruits, to be discussed by Prof. S. A. Beach, Ames, Iowa.

(3) Cooperative work in the improvement of wheat and corn, Prof. T. L. Lyon.

(4) Cooperative work in the improvement of cotton, J. F. Duggar, Auburn, Alabama.

(5) Cooperative work in the improvement of small fruits, Prof. W. M. Munson, Orono, Maine.

The committee has been at work gathering information in these respective fields, but is able at the present time to make only a report of progress.

The Department of Agriculture is already in cooperation with a large number of experiment stations in the handling of many projects relating to plant improvement. The cooperative arrangements have been so provided that certain individuals at the stations are assigned to special projects under some competent direction, the Department assisting with the advice of its experts and in securing or introducing plants from foreign countries which may be needed in the work and in sharing the expense of the work. This arrangement is usually in written form. The memorandum of agreement between the Department of Agriculture and the Minnesota Station, submitted herewith, is a sample of such an agreement. This sort of work has been going on for a number of years, and has resulted in developing the plant breeding and plant improvement work at quite a number of stations.

Professor Beach in connection with the improvement of orchard fruits has already taken steps toward cooperative work in the improvement of the apple. The matter was presented to the Association of Agricultural Colleges and Experiment Stations by the horticulturists in attendance at the graduate School of Agriculture at Urbana, Ill. A copy of said recommendations is attached hereto. It is the intention of the Department of Agriculture to assist in collecting the material for this work and in arranging for its proper use in such breeding work as may be undertaken.

A preliminary report by Professor Munson relative to the cooperative breeding of small fruits is also attached hereto. Attention is called in this report to the fact that it is often unsatisfactory to cooperate in the special development of new hybrids or in their testing until the testing has reached a general stage. This is, unfortunately, true, but it is our hope that there may be a development of the cooperative idea, at least so far as cooperation would be helpful. There are many problems in plant improvement that can be solved only through cooperative effort. The committee hopes to be able to point out in future what can and what can not be solved in that way.

The following is the scheme for cooperation between the Federal Department of Agriculture and a state experiment station:

PLAN FOR COOPERATION.

MEMORANDUM OF UNDERSTANDING BETWEEN THE MINNESOTA AGRICULTURAL EXPERIMENT STATION AND THE BUREAU OF PLANT INDUSTRY, UNITED STATES DEPARTMENT OF AGRICULTURE, COOPERATIVE WORK ON CEREALS AND FORAGE AND OTHER CROPS.

The objects of these cooperative investigations shall be to improve the wheat industry of the Northwest by originating, developing, and distributing varieties of wheat better than those now grown, especially with regard to the nitrogen content, hardiness, drought resistance, yield, rust resistance, quality of grain, etc.; to improve such other field crops as may be arranged for; to study, describe, and classify in a definite manner the varieties of cereals now grown in the Northwest, with a view of establishing more definitely the identity of the varieties in cultivation and such other problems in this connection as may be arranged for; and to determine the best systems of crop rotation; also to bring about closer and more effective cooperation between the Bureau of Plant Industry and the stations cooperating under this general plan, and among the stations themselves.

For the purpose of carrying on these investigations, it is proposed:

(1) That the Minnesota Agricultural Experiment Station, subject to the approval of the governing board, shall provide the necessary land and buildings, teams, machinery for planting, cultivating, harvesting, and threshing, and all common labor and laboratory materials and apparatus, except such as the Bureau of Plant Industry may furnish from time to time.

(2) That the Station shall make available as a basis for carrying on this cooperative work seeds and varieties under process of improvement and other results obtained from experiments conducted at the Station.

(3) The cooperative work shall be directly in charge of the Agriculturist of the Station, who shall be appointed a collaborator in the Bureau of Plant Industry.

(4) The Bureau of Plant Industry, subject to authorization by the Secretary of Agriculture, shall furnish the seeds of such foreign crops as may be deemed desirable to introduce or test in this region, and shall provide special agents capable of carrying on the investigations under the immediate charge of the Agriculturist or other competent officer of the Station, the personnel of agents to be determined jointly by the Station and the Bureau.

(5) The investigations which are carried on in accordance with this understanding shall be planned and conducted conjointly by the duly authorized representatives of the Station and of the Bureau, and shall be subject to the approval of the proper authorities in each case.

(6) The seeds of all new varieties of special value developed during these investigations shall be distributed in the localities in which they prove to be of value, the distribution to be made in accordance with such plan as may be jointly agreed to by the Station and the Bureau. In the larger plat tests of introduced varieties one-half the amount of grain produced from each variety in excess of the seed required for a second sowing, in all cases where the seed came from the Bureau of Plant Industry, shall be subject to the disposal of the Bureau, the other half to remain the property of the Minnesota Agricultural Experiment Station, provided that when sown under field conditions in areas of two acres or more, and the Bureau of Plant Industry bearing no expense in the cultivation of the crop, all seed harvested shall belong to the Minnesota Agricultural Experiment Station after deducting the amount of seed originally furnished by the Bureau; provided further, that in case the seed is not desired for distribution the whole will revert to the Minnesota Agricultural Experiment Station and said Station agrees to apply the proceeds of any grain sold from these cooperative plats to the continuance of such experimental work.

(7) Both the Station and the Bureau shall be free to use in official correspondence and in publications the results obtained in the investigations, proper credit to be given to the fact that such results have been obtained from the cooperative work. In case of publications, the Minnesota Agricultural Experiment Station shall give preference to results that are of interest to the State of Minnesota, and the Bureau of Plant Industry shall give preference to results that are of interest to the general region in which the crop or crops under consideration are grown. The Station shall also furnish to the Bureau when required suitable reports covering the cooperative work for publication, said reports to cover the work done according to this understanding.

(8) It is understoood that nothing herein contained shall be construed so as to in any way interfere with work that is already in progress or planned by the Bureau or the Station.

(9) The Station agrees that the rights and interests of the originators or introducers of each valuable variety shall be respected, and, so far as practicable, the time and manner of distributing such variety shall accord with the wishes of the originator or introducer.

(10) All employees of the Minnesota Agricultural Experiment Station accepting appointment from the Bureau of Plant Industry in connection with this cooperative work shall be subject to the Station and shall accept appointment only as approved by the head of the Station.

(Signed) WM. M. LIGGETT,
Director, Minnesota Agricultural Experiment Station.
B. T. GALLOWAY,
Chief, Bureau of Plant Industry.

The following contribution to this report was submitted by W. M. Munson, of the Agricultural Experiment Station, Orono, Me.:

COOPERATIVE BREEDING OF SMALL FRUITS—WHAT HAS BEEN DONE; WHAT CAN BE DONE.

In the breeding of plants, as of animals, the personal equation of the breeder enters very largely into the problem, and it is very seldom that two people can be brought together who will look upon a given problem from the same point of view. Many an enthusiastic plant breeder has laid well his plans, and distributed seeds or plants to widely separated districts, in the hope of solving some of the problems which have puzzled horticulturists for many years, only to find that, at the end of one, two, or at the most, three years, the work in which he himself had been so deeply interested had been side-tracked by the cooperating parties because of local conditions or flagging interest. As a result of several such experiences, the writer was somewhat skeptical in regard to the practicability of cooperative work in the breeding of small fruits, and accordingly enlisted the assistance and experience of several leading horticulturists, from all parts of the country, in an attempt to arrive at some common ground which should be in advance of the present knowledge of the subject.

Almost invariably the experience of station horticulturists in cooperating with the average farmer has been disastrous. In West Virginia some years ago Doctor Myers found as a result of trusting to

the cooperation of farmers that but *one* out of 708 experimenters in wheat made any attempt to carry out instructions, and his conclusion as a result of this bitter experience conforms to that of every other careful breeder: *Experimental work must not be entrusted to persons unfamiliar with scientific methods.*

I give below, without using the names of correspondents, a brief summary of replies received in answer to questions asked relative to experience in cooperative breeding and the practicability of future work in this direction:

Work done.	*Suggestions.*
OHIO.	
No cooperative work undertaken.	Cooperation in the selection of seedlings is the only practicable line.
COLORADO.	
Nothing has been done or is being done in Colorado.	Does not believe cooperative work at all practicable, except in testing new kinds.
CANADA.	
Very little has been done except to send seedlings or new varieties to individuals for further test.	The main value of cooperative work in breeding small fruits will be in finding the adaptability of different new varieties to a wide range of climatic conditions.
MICHIGAN.	
Nothing done except to test new varieties and aid originators to disseminate them.	Cooperation between stations and individuals may be very helpful in testing a given variety under different conditions.
CANADA.	
Work of variety testing very extended; about 2000 growers conducting tests and reporting annually. This includes tests of Station seedlings and varieties received from originators. Effort made to induce cooperative growers to select individual trees and plants for propagation and development of improved strains.	Believes cooperation practicable along lines indicated, but would not depend upon the general growers beyond this; though there may be occasional men who are capable of such assistance.
MICHIGAN.	
Has arranged program looking to assistance from State Horticultural Society. Will place promising seedlings with members of the Society for trial and encourage individual selection.	Believes cooperative work in breeding small fruits practicable if the cooperator is reliable. Would make a duplicate statement of work to be done and directions for carrying it out.
MINNESOTA.	
Has encouraged raising of seedling fruits by offering premiums.	The principal value of cooperation is in educating public sentiment.

IOWA.

Varieties are tested at the experiment station and distributed to branch testing stations for trials under different conditions.	Under proper management cooperative breeding of small fruits is practicable. If proper men can be secured to assist, cooperative work is a great advantage over local work at the experiment station in determining merits of any given fruit.

VERMONT.

So far no work has been done along this line.	As a rule, cooperative work with individuals, unless in exceptional cases, is not satisfactory. Does not know a single person in this State who is actually breeding small fruits.

NEW YORK.

Does not know of any cooperative experiments in breeding small fruits.	Sees no reason why cooperative work in breeding small fruits is not feasible. The principal difficulty lies in finding the man who is interested in it and deciding upon lines of work equally valuable in different sections of the country.

MASSACHUSETTS.

Cooperation is of value in testing the value of new varieties, but no successful cooperative plant breeding arrangement is known.	Plant breeding, either for fruit or flowers, is for the most part a labor of love. Carefully bred seed and young seedling plants should not be subjected to the liability of neglect incident to being "farmed out."

From the above it is evident that there is a widespread lack of cooperation at present, and a general feeling that such work, aside from variety testing, is impracticable. The frank avowal of one correspondent from Massachusetts—"Don't know a thing about it"—very nearly covers the ground of past experience in the direction of cooperative breeding of small fruits.

As to the future, little more can be said. The obstacles have already been pointed out. In the judgment of the writer, cooperative breeding of fruits, aside from mere variety testing, as already suggested, must be restricted to such work as can be placed under the general supervision of the United States Department of Agriculture. Arrangements may be made for the details of propagation and culture, but notes and observations must be made by the same individual in different localities, in order to avoid the personal element. In the details of propagation and culture, too, there is great danger of error, from the inevitable lack of individual interest in the problem under consideration.

Among some of the problems incident to the improvement of small fruits which may possibly to a greater or less extent be taken up in a cooperative way are: (1) The development by selection of disease-

resistant types; (2) the improvement of types by selection of bud variations; (3) the crossing of species and varieties, and the subsequent fixation of new types; and (4) the development of types suitable for southern conditions. Aside from these and a few similar questions, it would seem that the problem of small-fruit breeding must be solved by individual rather than by cooperative effort.

PREVENTION OF DEGENERATION THE ONLY PRACTICAL EUGENICS.

By CHAS. E. WOODRUFF, M. D., *Plattsburg Barracks, N. Y.*

The word eugenics has been so misunderstood that it would be better to substitute an English equivalent which is in common every-day use—"good bringing up." In the first place, whenever the idea is suggested that some means must be taken to lessen the terrible modern burden of the pauper, insane, defective, and criminal, and that the race must be made better, it is at once imagined that the only way to do it, is by copying the methods of the plant and stock breeder. Although these methods are hopelessly out of the question, the full absurdity of applying them to man is not realized until the matter is explained. Luther Burbank, for instance, by the use on a grand scale of methods long known and practiced by other plant breeders, has accomplished very marked results in "improving" his varieties. He finds a few variations among say a hundred thousand specimens, saves these two or three and kills the rest. It has been seriously stated that such success shows what we could do in the case of mankind, as though it were possible for us to keep a few men and women for matrimony and destroy the rest or sterilize them.

The selection of life partners is under the influence of laws which we do not pretend to understand but which we cannot disturb. The only thing known about the matter is a greater or less tendency found, in common with some of the domestic animals, to mate with opposites. It seems to be an inherited instinct and due to the fact that the offspring are thus kept nearer to the average—such specimens being better fitted for survival than those which vary too much. The whole animal world thus in time becomes descended from parents having this tendency to keep species together and not to scatter them. New types arise only when new variations are produced from other causes and are better fitted for survival or at least not unfitted. In man as in other species, the immense majority of variations are predestined to disappear. Old types, if adjusted to the environment, survive in remarkable purity. The peasant of the Nile, for instance, though repeatedly conquered and mixed with other types is identically the same as pictured on the oldest monuments.

The tendency of man, as well as the higher animals, is of course to mate in his own species and in the vast majority of cases, in his own

variety and also in his own social layer. Nevertheless, there is a remarkable attraction between opposite variations in that limited sphere of selection. They are the happy and successful marriages. And it is common to find utter failure when the partners are similar either in exceptional physique or mental qualities. The reasons for this, of course, are wholly unknown, except as above mentioned, but it emphasizes the fact that the suggestions to select similar mates for marriage to exaggerate their qualities in the offspring is unnatural and bound to fail. A few absurd experiments have been made without success. In addition, selected marriages violate the normal moral sense of the higher races, and this of itself is unnatural, for morality in the long run is highly scientific as it is the crystalization of natural laws followed instinctively. Immorality is contrary to nature. Any immoral proposition of this character must be frowned upon as unscientific as well as immoral.

Then again, stock and plant breeders, either in cross breeding or by ordinary selection, are generally compelled to devote their attention to the exaggeration of one character, ignoring the rest, or to the combination of a very few characters rarely more than two. Now suppose that it would be possible to do such an unnatural thing as to select human mates instead of letting them do their own selecting, what characters would we wish to increase? If good physique were the ideal, the result might be lacking in intelligence or morality. If more intelligence were desired, the result might be too frail to be perpetuated. Even if we could combine several characters we might produce something which would be wholly unfit for the unknown future environment which advancing civilization is creating. In every way it is viewed, any suggestion towards compelling the young to marry except as their instincts direct, is unnatural, unscientific, and absurd. They cannot be guided, and we must let nature decide; for she will reject the unsuitable in time and the race will always be adjusted by the survival of the fittest. The material is plenty even with our reduced birth rate, for the world's population increases very slowly and there is a surplus for natural selection to work upon. At the present moment certain types in America are disappearing because unsuited to the climate and they are types we would like to preserve, too, but we cannot. I have fully explained the matter in the work on "The Effects of Tropical Light on White Men" (Rebman Co., New York), where the data can be obtained.

In what direction, then, must we look for means of improving the human race, if we cannot possibly create variations or exaggerate those naturally produced for us? Clearly there is only one way, and that is by discovering what causes the worst varieties, and then removing those causes. There is a growing unanimity of opinion that these enemies or parasites upon society are due to remediable causes and are not hereditary in any sense of the word. Indeed some recent prison statistics show that the vast majority of criminals are the children of parents who were moral or at least whose immorality had not

extended to discoverable crimes. Very few criminals are descended from criminals and therein is another natural law which is of extreme importance. Aberrant types in every species promptly disappear as a rule, as unfit for survival, and our criminals do not tend to produce a hereditary criminal class. The famous study of the exceptional Jukes has given the opposite impression and brought forth a host of suggestions for the sterilization of vicious people to extinguish lines which nature extinguishes for us as a rule. And right here it is proper to remark that no suggestion for sterilization has ever been taken seriously by the medical profession except by a minute fraction, because it has never been proved that it would do any good. Criminals are young as a rule and we can assert, therefore, that 95 per cent of the offenders of the years 1927 to 1930, are now being born—not of criminal parents, but in respectable households. Their numbers will not be limited in the least by attacking the present day criminal, but by attention to the normal population. Now what has caused so many of the children of normal parents to drift into crime? What is the cause of so much blindness, deafness, lameness, feeble-mindedness, pauperism, and general inefficiency? The whole trend of biological investigations, both among physicians and laymen is in the direction of considering the causes as something in the environment, and as something removable. Occasionally, of course, there is clear cut evidence that certain defects are inherited from defective parents, but even in some of these cases, there is a wealth of evidence that if the infant had been properly reared in hygenic surroundings, the defect would not have appeared or would have been of minor degree. Bad food, bad housing, bad clothing, and thousands of other adversities have pounded the poor infant from the moment of birth. Some of the little sufferers were damaged before birth or even before conception. Many of these adversities are removable, of course, though the infant may be so damaged at birth, that no amount of care will enable it to grow to a normal maturity. The treatment should have begun with the grandparents.

The means of remedying the surroundings of the poor do not concern us here, but it might be said, in passing, that a poor man of such low order of intelligence that he can do only "laboring" work, say at $1.50 per day, cannot earn enough to support a wife and six or eight children in our civilization. Formerly in such families, every child had to do its share and the women too, but the labor was usually wholesome—generally outdoors—and health did not suffer. Modern industrialism has created conditions in which children cannot work without serious injury to health, and modern civilization demands that each child shall be educated to a certain degree. Hence we are forbidding child labor and compelling school attendance, so that the family is deprived of the income of the children's labor needed in all past ages. A certain amount of starvation is therefore unavoidable, and we need not be surprised that ten million of our people are underfed. This results in degeneracy. It is a wise man who can suggest

remedies. In other words, a certain amount of race deterioration is not remediable at present, but might be in time.

There is another class of irremediable causes of degeneracy, which is now occupying medical thought. It is known that much human defect is due to toxins of diseases afflicting the mother during pregnancy or shortly before—tuberculosis, typhoid fever, pneumonia, and the like. The more efficient our sanitation becomes, the fewer such cases, so that prevention of these defective offspring is a mere matter of time.

As for alcohol, once considered the king among causes of about everything for which we did not know any other cause, we are now in a transition stage. It has been proved innocent of many of the charges against it, and though we still consider it a devil, it is not as bad as it was once painted by fanatical enthusiasts. Alcoholism is generally a result of nervous diseases caused by something else. In its turn it does more damage, but many of the things claimed as its progeny are merely results of the original nervous disease which caused the alcoholism. Consequently the temperance crusade, though beneficial in raising the racial standards, can only do so to a limited extent. Even universal abstinence will be ineffective, for some of our worst degenerates come from abstaining parents.

Medical science has been largely occupied in curing and saving the defectives and not in preventing their appearance. The results are deplorable as far as race decline is concerned, though not as bad as they appear at first sight. The conditions may best be explained by comparing the upper and lower classes, where opposite methods have been practiced. The peasant woman is very prolific, but so stupid that she cannot care for the babies, most of whom, therefore, die unless they are extraordinarily strong. This terrific infant mortality is natural selection in the usual way and it is the method of stock breeders. Only the strongest survive to produce offspring of their own. The peasant is therefore noted for ruggedness. All of the boys go into the army and survive conditions which would kill an American army. In the higher classes the same infantile mortality was formerly the rule, but being possessed of greater intelligence, they began saving the babies. Pregnancy is too expensive a process and the birth rate had to diminish. There are more survivors of an upper class English family of 6 than in a peasant family of 10. Medical science saves what formerly perished from feebleness. But note this difference—these means of child saving are taken by the intelligent classes who are thus increasing proportionately while the stupid let their children die. Thus the English race is increasing in average intelligence, through the selection of the most intelligent. There has been alarm in England because of the difficulty of recruiting the army—strong men could not be found in sufficient numbers; that is, strong enough to bear the burdens. It is a false alarm. A thousand little men of brains are a match for ten thousand stupid giants. The military methods must change to suit the national type—a matter which comes home to us in America where weaklings are being saved to an enor-

mous extent, instead of dying off as in former times. Yet the conditions are not so bad, after all. It has been found that the well fed upper classes in England are really bigger, stronger, and in every way superior to the half-starved lower layers. The reduction of the birth rate seems to leave more food for the fewer children, so that there is a positive advantage in the small birth rate, so common among the well to do.

The cure of this alleged deterioration, is then in the direction of preventing the frailness. The physicians would not have so much to do in saving frail types if there were fewer of them born, and there will be fewer born as soon as we find out the causes of the frailness. We cannot adopt the peasant method of simply allowing the feeble to perish, nor can we go on as at present. Saving the weaklings causes too great a racial decline. The proper course is to teach the public how to live properly so as to be in perfect health for procreation, and how to raise the babies. A great bishop has stated that it is a crime to bring into the world 10 or 15 babies which cannot be properly fed. But that is not the main point after all. It is how to reach the lower class woman to teach her how to raise her babies, instead of allowing them to survive or perish as fate decides. The subject is more or less under constant discussion in the medical profession, and many are the suggestions for a campaign of education as to sanitation. Physicians as a rule do not like to appear in lay public prints, so that there is a growing tendency throughout the civilized world, to form associations whose object is the instruction of all classes in proper methods of living, and of warning them of modern dangers due to certain diseases.

Temperance organizations no doubt accomplished much, but as before explained, alcohol is not guilty of all the accusations hurled against it. Modern life demands sobriety in so many callings, that the drunkard is being thrust to the wall. Practical temperance is coming as a matter of course. Indeed, life in a big city would not be safe, if all motormen, drivers and electric employees, would get drunk in the manner common among workmen a century or two ago. Health also is a prerequisite to employment, and all ambitious young men are striving for it. It does seem that there has been a progressive improvement, if we are to believe the stories told of the cities of two centuries ago, and the horrible classes they sheltered. Eugenics is becoming a necessity of civilization, and by eugenics is meant the rearing of healthy children, not the selection of partners. What is a necessity, soon exists as a matter of survival of the fittest.

To sum up, then, the duty of society in the investigation of human heredity, is to study all the reasons why feeble, frail, or defective offspring are born in violation of heredity. Then it will be a simple matter to remove the removable causes, and thus raise the racial standard. In conclusion it may be pointed out that one cause is wholly out of our control. It is now proved that races differ to suit them for their respective climates, and that extinction follows a migration to a markedly different one. Recent statistics I have gathered, show that a certain type in America is being afflicted with tuberculosis to a

much greater extent than others and that it is becoming affected with nervous diseases, and therefore drifts into vagabondage and crime as a result of this instability. No amount of care can prevent this. Racial decay of some of the types in America is inevitable. This does not alter the main proposition, that a study of heredity will prove that defects are often due to remediable causes and are not hereditary in any sense of the word. Public education in proper methods of living to increase racial vigor is the coming duty of sanitarians.

Every improvement of water supply, sewerage, or other municipal sanitary matter, means less sickness, and stronger infants born, and a better type of the next generation. Every parent who can be induced to eat properly of nourishing food, is thereby enabled to be a progenitor of better types than himself.

Sanitation in its broadest sense is the only eugenics, for it prevents degeneration.

Finally, regeneration is a natural law. Degenerate or frail types often disappear through the birth of normal offspring. That is, the tendency is always towards the normal and not away from it, if the family lives a normal life. It is our duty to teach "the normal life" in its simplicity. Heredity heeps us in the straight and narrow path if we will only live "the normal life."

STATISTICS OF COTTON VARIATION.

By D. N. Shoemaker, *Washington, D. C.*

The work here reviewed was undertaken in connection with the problem of breeding varieties better adapted to weevil-infested regions. The character which promises most thus far in this direction is undoubtedly early maturity. Along with this, however, several other things must be remembered, or the resulting early cotton will be undesirable from the lack of valuable characters which are not correlated with earliness. These other characters are size of boll, percentage of lint to seed, length of lint, and "storm-proof" character, by which is meant the ability to retain the seed cotton in the opened bolls for a long time and against wind and beating rain.

Most of the cotton varieties grown at present are badly mixed. This has resulted from lack of care, and also because it is a much more difficult thing to keep the seed pure than in other crops—corn for instance. It is often difficult for the planter to persuade the gin owner to gin his select cotton so as to prevent mixing with seed of previously ginned cotton. The varieties in the State of Texas which show anything like a good degree of uniformity are not over a half score, among some sixty or more cultivated. Thus, when one starts a selection he usually has quite a varied lot in the field to work on. This first year's selection is, in cotton, as indeed in all selections, a sort of "variety testing," the second year's breeding plat showing as many "varieties"

as there were plants selected the year before. There is no need of statistics to show the great advantage of some of these progeny rows over the others. The variations in earliness and the other characters are, of course, more marked this year than any following.

This statistical work was undertaken to try to get some idea of how much gain in a desirable character might be expected from the progeny of a single plant; also, how this gain might be affected by cultivation and seasonal variations, or if any variations might be moderately independent of the season. The best way to do this would have been to follow all of the second year's progeny of the selected plants, and a large number of those of the succeeding year, but the small amount of time that could be devoted to the subject along with the great amount of labor required, has kept the number of plants tabulated within comparatively narrow limits.

It was planned to make the experiment applicable to the ordinary breeder's conditions, and so it was decided to tabulate the progeny of a few field-fertilized plants through several generations, allowing them always to be field-fertilized. Cotton is visited by bees and other insects, and there is quite an amount of cross fertilization, which may vary with the number of bees present, and which Webber has placed as about 10 per cent between Egyptian and Upland cottons.* There are no statistics to show how much cross fertilization normally takes place between Upland varieties. This was left out of account in this work as here reported. Later work has been added to include the progeny of close-fertilized plants, and hybrids of known parentage which have been close-fertilized in following generations. The characters chosen for tabulating were size of boll and percentage of lint to seed, because they can be more accurately measured than earliness, length of lint, or "storm-proof" quality. The cultivation given has been that of ordinary field crops during the first year, 1905, and a little better than that in 1906.

The variety chosen is one called Bohemian, and the selections were made near Paris, Texas, on the black waxy lands characteristic of north central Texas. Selection was begun in the fall of 1904. Plants were chosen for earliness mainly, but length of lint and size of boll were both noted in the field, and percentage of lint was found in the laboratory. In getting size of boll, 10 representative bolls of each plant were chosen and were weighed on an accurate balance. In getting the percentage of lint from 5 to 7 locks of cotton were taken from different parts of the plants and delinted by hand. The seed and lint were then accurately weighed. This is very tedious work, but it seems the only way to get an accurate idea of the percentage of lint of a given plant.

Of these Bohemian selections, 5 plants were chosen, which are called here Nos. 1 to 5. These were grown in 1905 near Paris, Texas, on typical black waxy soil with good field culture. The season in north

* H. J. Webber, Proceedings American Breeders' Association, Volume I, 1905.

Texas in 1905 was very unpropitious, being much too wet in the early part up to the end of July. The plants were quite small, and left ample room to walk between the 4½-foot rows. The crop was less than one-half bale per acre. From each of these rows 25 progeny plants, making 125 plants in all, were taken for tabulating. These were taken, beginning at one end of the row and picking the first 25 plants

Results of two years' selection work with Bohemian cotton.

Plant number.	Original selections, 1904.		Progeny plants—1905.					Progeny plants—1906.				
	Wt. of 10-boll sample.	Per cent of lint.	Number of plants.	Wt. of 10-boll sample.	Gain or loss.	Per cent of lint.	Gain or loss.	Number of plants.	Wt. of 10-boll sample.	Gain or loss.	Per cent of lint.	Gain or loss.
	Gms.			*Gms.*	*Gms.*		*P. ct.*		*Gms.*	*Gms.*		*P. ct.*
1	95.2	31.4	25	62.1	−34.2	32.0	+ .6	43	71.7	+ 9.6	29.5	− 2.5
1-1.....				60.0		35.3		12	73.9	+13.9	29.7	− 5.6
1-2.....				47.6		28.4		9	64.9	+17.3	26.5	− 1.9
1-3.....				74.4		30.0		8	85.9	+11.5	31.9	+ 1.9
1-4.....				54.7		32.5		14	66.3	+11.6	30.1	− 2.4
2	63.4	27.7	25	57.9	− 5.5	27.1	− .6	55	64.6	+ 6.7	26.2	− .9
2-1.....				55.6		29.8		14	66.4	+10.8	28.2	− 1.6
2-2.....				42.4		31.2		12	59.3	+16.9	27.3	− 3.9
2-3.....				50.2		34.7		9	64.7	+14.5	25.6	− 9.1
2-4.....				66.0		33.0		8	70.2	+ 4.2	22.0	−11.0
2-5.....				45.7		28.0		12	64.2	+18.5	25.8	− 2.2
3	51.4	34.5	25	47.5	− 3.9	33.8	− .7	63	58.5	+11.0	30.1	− 3.7
3-1.....				43.0		35.8		10	58.4	+15.4	30.3	− 5.5
3-2				57.0		34.0		11	54.3	− 2.7	29.5	− 4.5
3-3.....				44.4		31.0		13	56.4	+14.0	28.6	− 2.4
3-4.....				40.0		35.1		10	58.4	+18.4	31.4	− 3.7
3-5.....				51.0		32.6		8	61.7	+10.7	31.6	− 1.0
3-6.....				51.6		32.5		11	63.4	+11.8	30.5	− 2.0
4	63.0	32.8	25	48.5	−14.5	31.9	− .9	59	63.2	+14.7	30.3	− 1.6
4-1.....				48.2		36.7		10	66.3	+18.1	32.8	− 3.9
4-2.....				66.0		33.0		9	69.2	+ 3.2	30.8	− 2.2
4-3.....				40.0		33.1		11	57.1	+17.1	32.9	− .2
4-4.....				46.4		30.1		12	72.1	+25.7	29.3	− .8
4-5.....				44.4		32.3		9	57.0	+12.6	30.1	− 2.2
4-6.....				45.4		28.0		8	54.7	+ 9.3	25.3	− 2.7
5	72.2	36.0	25	49.2	−23.0	34.6	−1.4	40	59.2	+10.0	32.0	− 2.6
5-1.....				50.6		34.3		8	67.5	+17.1	30.7	− 3.6
5-2.....				38.8		24.4		11	60.2	+31.4	31.7	+ 7.3
5-3.....				45.4		39.2		11	56.4	+11.0	34.1	− 5.1
5-4.....				61.6		31.4		10	54.5	− 7.1	31.2	− .2
Avg..	69.0	32.8	125	52.6	−16.4	31.7	−1.1	260	63.2	+10.6	29.5	− 2.2

in each row. From the progeny of these 5 plants 25 representative plants were chosen for growing in 1906. These were planted in the plat at the cotton laboratory, Waco, Texas, where space was limited, and about 260 plants were grown from these 25. All these were tabulated in 1906. This piece of ground was very fertile, and had an application of cow-lot manure besides. The rows were scant 4 feet apart and the plants about 26 inches in the rows. The season favored rank growth, and the plat became an impassible tangle with a height

of plant of 6 to 8 feet. The yield was between three-fourths and one bale per acre. The accompanying table shows the result of the two years progeny record. The weight of the 10 boll samples is given in grams. Each plant is followed in the same line by its progeny record —1-1, 2-1, etc.—meaning the second year selections of the plants No. 1 and No. 2. The most noticeable thing in the table is that the average percentage of lint of the progeny decreased in both years in nearly every case. There were, of course, isolated plants that exceeded the record of the parent. There seemed to be no tendency for the plants of low percentage to breed closer to the mean of the variety by increasing the percentage. The loss was greater in 1906 than 1905. The next noticeable point is that the size of boll decreased very greatly in 1905, and that it increased almost as much in 1906.

The general character of the decrease in percentage seems to show that it is due to season or culture, yet the starved water-soaked condition of 1905 was not so bad as the over-crowded rampant growth of 1906. The general condition of the plants in 1905 is reflected in the decreased size of boll, and the favorable growth of 1906 is also quick to show itself in the returning size of boll. There is probably no character that is not largely influenced by the character of season and of cultivation.

The lessons taught by the experiment so far seem to be:

1. **The check row system, giving each plant abundant room, say 4 by 4 feet, is the best way to get at individual excellence.**
2. **It shows the value of making a large number of selections for it is hard to "pick the winner" in the first year's selection.**
3. **It emphasizes the value of fairly complete progeny records.**
4. **It shows that the breeder should not be entirely cast down if in a bad season he seems to see all the desirable characters dropping out of his plants. They will probably return with better times.**
5. **That the breeding plat should have better care than the farm. For it will be possible in this way to enlarge the variations in any one character.**

The record has not yet gone far enough to give much light on how much gain may be expected after the first year's "variety testing." It is hoped to carry this part of the experiment to a point where it may be further reported upon in the future.

A PLEA FOR A MORE EXTENDED USE OF THE SYSTEM OF LIVE-STOCK REGISTRATION.

By M. M. Boyd, *Bobcaygeon, Canada.*

Registration of the pedigrees of improved live-stock has only been generally adopted by breeders within the last thirty years or thereabouts. For, although the General Stud Book for Throughbreds (English Race Horses) was founded in 1791, and Coate's Herd Book for Shorthorn cattle begun in 1822, registration was not generally adopted until many years later. The first volume of the Hereford

Herd Book was published in 1862, and that of the Polled Angus and of the Galloway appeared the same year. The Clydesdale Stud Book first appeared in 1878; the Suffolk Horse and the Shire Horse Stud Books in 1880; the Percheron Stud Book of France in 1883; the Cleveland Bay and the Hackney Stud Books in 1884; and the Yorkshire Coach Horse Stud Book in 1887.

Coupled with the privilege of registration in these volumes, restrictions were in every case put upon the breeders, confining (at first with some license but later strictly) their operations within certain lines, and the effect of these restrictions has resulted in fixing to type many breeds which were formerly somewhat diversified and confused, so that now we have a large number of varieties of remarkable uniformity, which reproduce themselves truly.

While these restrictions have had this good effect, they have doubtless during the past two decades prevented the use of many animals, i. e., the adoption in many cases of certain crosses, which would have resulted in great improvement. Most breeders can call to mind in the records of the particular breed in which they are interested, instances in which a marked improvement was made by the use of a sire whose impure blood would have prevented his use in later years when registration lines were more closely drawn. One instance of this kind is the Clydesdale stallion, "Prince of Wales" (673), and another, the Suffolk stallion, "Cup-bearer 3d" (566), both progenitors of untold value to their respective breeds, but both of which would have been excluded from use, had the Stud Book doors been as closely shut in their time as now. So that while these restrictions have a powerful influence for good in conducing to fixity of type, they have also a baneful effect when they exclude blood from the register which if admitted would quickly advance the breed. In the case of two or more distinct varieties each bred for exactly the same useful purpose, as for example, beef in cattle, or draft in horses, one of these may have (and as a matter of fact all do have) a characteristic or well established point of excellence which is lacking altogether or rarely exhibited in one or more of the other varieties. Any interchanges of blood to secure these points of especial excellence, which might thus be gained by one breed from the other, are prohibited by the restrictions coupled with each register. Nevertheless, these restrictions are a decided necessity, and I do not see any scheme for more license which would not be fraught with danger to the breed adopting it. Therefore, we find ourselves in a dilemma betwen necessary restrictions attached to our present registers and the need for more freedom if we are to make the rapid progress that we should.

A way out of this dilemma may, I think, be found in the adoption of more registers, and in order that my meaning may be perfectly clear, I will give an example of one or two such registers:

Example No. 1.—A register involving Hereford and Angus cattle with the object of grafting on the Hereford the polled head and more general tendency to exceptionally well-marbled flesh for which the Angus is celebrated. The first volume open to pure Hereford blood,

and to Hereford mixed with not more than 25 per cent of Angus blood. The percentage of Angus blood to be further restricted in later volumes.

Example No. 2.—A register involving Percheron and Shire horses with the object of grafting on the Percheron the greater bone and weight of the Shire. The first volume open to pure Percheron blood, and to Percheron mixed with not more than 25 per cent of Shire blood, etc.

If we were forthwith to adopt several new registers, such as I have crudely outlined, and could secure sufficient patronage for each, it is not only possible, but extremely probable, that in the next two decades we should advance much faster than if we continue to confine ourselves within the lines of the present purebreed registers. I should be loath to see any of our purebreed registers relax its strict rules of entry, and so risk the dissolution of the animal type it has taken so many years to fix, but without interfering with these, and while still maintaining all these strictly, I cannot see any reason for confining ourselves to them. Our forefathers handed down to us the large number of excellent varieties with which the past two generations have been engaged—gathering them carefully into their respective folds, supplying them with registers, firmly fixing their several types, multiplying the number of individuals, and greatly improving their general standard of excellence. So much excellence has been attained that there are persons who say that we have nearly reached perfection in our breeds of horses, cattle, sheep, and swine. Nevertheless, if we compare these more important animals with dogs in respect to the number and perfection of varieties adapted to man's use, the comparison will help us to appreciate how far we are still behind the possibilities. Having then all this good material, these purebreeds, each so securely safeguarded by books of record and registration societies, that we can afford to experiment without the fear of extinction to any of them, which was a real and grave danger before these safeguards were established, it would appear to me reasonable and progressive to design plans for making more varied use of this material than at present. To leave such work to individual enterprise is to leave it undone; for the individual cannot afford it, and if he could, would still need cooperation to be successful. The first thing to be done after deciding upon the direction of each particular advance, and the breed or breeds to be involved, is to establish a register. The founding of the register would be the unfolding of the standard around which I think a goodly number of recruits would flock in the case of every well designed plan.

I will suggest another register of a character so general that it might properly be adopted by the U. S. Department of Agriculture. This we might christen tentatively, "The American Experimental Live-Stock Record," to have a section each for horses, cattle, sheep, and swine; to be open for the entry of all crosses between established breeds, and of all hybrids; to be under the supervision of a committee of professional men, and, in addition to the particulars usually given

in a stud or herd book, to give all details obtainable as to color, form, etc. To be published in the first instance in bulletin form at frequent intervals, so that the information might be available to breeders and students as early as possible. Such a book would preserve a fund of information (which would otherwise be largely scattered and lost) gathered from all those who by design or accident might make such crosses. It would be very valuable to breeders, and also to persons studying the laws of heredity. Many of the crosses recorded in it might, and probably would be, valueless in the ordinary sense, but nevertheless the record of them might be extremely valuable in discovering dominant and recessive characters, in respect to color, hair, horn, hoof, bone, sinew, muscle, fat, constitution, etc. Many who would like to make experimental crosses between purebred animals, are loath to lose registration. Registration in the Experimental Record would compensate to some extent for loss of registration in the purebreed records, and might eventually be considered quite as honorable and valuable. If desirable, it might be made as valuable by a commendatory form of registration certificate in worthy cases. Should the "Experimental Record" result in the forming of new varieties, it would have preserved in its volumes all the data with which to launch such varieties into independent existence, each with its own herd or stud book.

The foregoing remarks refer to advancement in the *van* of stock-breeding. The bringing up of the rear is likewise important, and a further use of registration would probably help this end along too. Local registers (for example, township or county registers), for grades, would probably encourage a more general use of purebreed bulls, and induce the farmer to take more interest in his grade females. These registers for grades would have to be extremly local, as otherwise they would soon become too voluminous.

Now, to conclude with a few more words: Notwithstanding the very short number of years since registration became general, some of our record books have already become exceedingly bulky. The annual flow of entries into them is becoming almost unwieldly, and is constantly increasing in volume. Might it not be advantageous to turn a portion of these streams into fresh channels? The Battle of the Breeds has always "given life" to stock-breeding. Would it not add more interest to bring on new contestants?

REPORT OF THE COMMITTEE ON BREEDING POULTRY.

By Prof. JAMES E. RICE, *Chairman, Ithaca, N. Y.*

The committee desires to submit the following report:

1. The great vital need in poultry husbandry at this time is more men and means with which to pursue scientific investigation. Almost no provision has been made by the Agricultural Colleges and Experiment Stations for investigating the important scientific problems per-

taining to this great industry. Of the 51 States and Territories in the United States, only 13 are conducting poultry investigations and most of these are working in a handicapped and limited way. The total amount of money expended annually in the United States for instruction and investigation in poultry husbandry, including buildings, stock, and equipments, is less than $75,000, which is less on an average than $1500 for each State and Territory; and this, notwithstanding the fact that the annual value of the poultry and poultry products is over $500,000,000.

2. Efforts should be made to systematize and coordinate the methods of keeping records of all breeding experiments conducted within the field of influence of the American Breeders' Association so that results along similar lines in the various States can be as readily compared as if the work had been performed under one directing head.

3. The various States should be encouraged and induced to undertake similar lines of breeding experiments so that there may be a systematic exchange of breeding stock, thus lessening the danger of evil results from too close breeding and having also the added advantage of an opportunity to compare results obtained.

4. Systematic breeding experiments should be undertaken along the following lines:

(*a*) To continue the valuable work already begun in several States, looking toward early production, prolificacy, digestive capacity, and production of large eggs, uniform in size, color, and shape, these experiments to be carried out with several of the most promising egg-producing varieties of poultry.

(*b*) To increase rapidity of growth, digestive capacity, and the development of an animal possessing improved meat qualities, and a carcass possessing the largest possible proportion of choice cuts with the least possible loss in dressing.

(*c*) To ascertain the influence of the vigor of breeding stock on the fertility and hatchability of eggs, and on the vitality, growth, prolificacy, and breeding powers of the offspring.

(*d*) To systematically undertake poultry breeding experiments that shall confirm or disprove the laws of breeding as already established with other classes of domestic animals. We believe that poultry, because of its variability and rapidity of multiplication and quick growth, offers exceptional advantages in studying the laws of breeding, one of the most fundamental being known—Mendel's law, and corrolaries thereto.

JAMES E. RICE, *Ithaca, N. Y.*
T. E. ORR, *Beaver, Pa.*
ARTHUR A. BRIGHAM, *Brinklow, Md.*
OSCAR ERF, *Manhattan, Kas.*
J. WILLARD BOLTE, *Kingston, R. I.*
H. L. BLANCHARD, *Chimacum, Wash.*
Committee.

GRADING IN AGRICULTURAL JUDGING CONTESTS.

By L. J. Briggs, *U. S. Department of Agriculture.*

An interesting and valuable feature of modern agricultural education is the development of competitive contests among students in judging and arranging in order of merit agricultural products submitted for examination. Thus, for example, the test may be to determine who can arrange a certain group of 5 ears of corn most nearly in order of excellence, the best ear, let us say, to be placed at the left. Since there are 120 permutations possible in the arrangement of the 5 ears of corn, the judges soon become hopelessly involved in complications unless some definite system of grading is adopted. President E. R. Nichols of the Kansas Agricultural College, appreciating this difficulty, has suggested a system of grading in which the penalty to be imposed for misplacing an ear is arbitrarily made much greater for the best ear than for the poorest. This plan does not seem to me strictly logical when applied to a general scheme of grading, since we have no reason for assuming that the best individuals can be more readily detected than the poorest. Furthermore, from a practical standpoint, it is quite as important for the student to recognize the deficiencies of a poor ear of corn as to appreciate the points of excellence in a good one. The plan suggested by President Nichols also gives rise to a rather complicated system of grading, necessitating the use of tables to determine the grade corresponding to any given arrangement; and, finally, it is not free from the ban of empiricism.

I have, therefore, ventured to call attention to the following system of preparing grading tables in which the difficulties mentioned above are avoided. This system can perhaps be most readily explained by referring again to a concrete case. Thus, if we assume that the error committed by exchanging the relative positions of the two poorest ears of corn is no greater than that resulting from changing the relative positions of the two best ears—or, in other words, if an error of displacement counts the same, no matter where it occurs—then the 120 permutations possible in the case of the 5 ears fall into 11 classes, and the grading becomes much simplified. To make the matter clearer, let us designate the 5 ears of corn by the numerals 1, 2, 3, 4, 5, arranged in order of excellence, No. 1, the best ear, being at the left. We assume then that the error committed by the student in arranging the ears 2, 1, 3, 4, 5 is no greater than in case of the arrangement 1, 2, 3, 5, 4, or 1, 2, 4, 3, 5, or any similar arrangement in which a single displacement occurs. Without specific knowledge of the individual characteristics of the objects to be arranged this assumption is the only logical one.

On the above basis, the complete failure of the student would be represented by the arrangement 5, 4, 3, 2, 1. In order to change the objects from this arrangement into the correct positions it is evident that the following displacements will be necessary:

1, 5, 4, 3, 2	4	displacements.
1, 2, 5, 4, 3	3	do.
1, 2, 3, 5, 4	2	do.
1, 2, 3, 4, 5	1	do.
Total	10	do.

By a displacement is here meant the interchanging of the positions of two adjacent objects. Thus in order to transfer No. 1 into its correct place from the arrangement 5, 4, 3, 2, 1, it is necessary to interchange it first with 2, then with 3, then with 4, and finally with 5, thus requiring four displacements, resulting in the arrangement 1, 5, 4, 3, 2. In order to get No. 2 into its proper place, it is evident that three displacements are necessary, and so on, requiring altogether 10 displacements, starting with the worst possible arrangement, in order to bring the objects into their proper sequence.

Therefore, since the greatest possible number of displacements is 10 in the case of 5 objects, if we grade the correct arrangement as 100 and the complete failure as zero, all other possible arrangements must fall into some one of the 9 intermediate classes and may, therefore, be graded as 90 per cent, 80 per cent, 70 per cent, etc., according to the number of displacemnts necessary to bring the objects into the correct arrangement. The following examples will serve to illustrate this:

2, 1, 3, 4, 5	1 displacement	90 per cent.
2, 3, 1, 4, 5	2 displacements	80 per cent.
1, 3, 4, 5, 2	3 displacements	70 per cent.
3, 4, 2, 5, 1	6 displacements	40 per cent.

A little practice enables the correct grade to be determined simply by inspection. If tables are desired, they can, however, be very quickly calculated and possess a symmetry whereby checking is made easy.

As the number of objects in the group increases, the number of permutations or possible arrangements increases at an enormous rate, making some definite system of grading a necessity. This is well illustrated in the following table, in which the total number of permutations or arrangements possible for different groups of objects up to 10 is given, together with the maximum number of displacements necessary to bring each group into a correct arrangement, and the corresponding percentage value of each displacement.

Number of objects in group.	Number of possible arrangements.	Maximum number of displacements.	Percentage value of one displacement.
2	2	1	100.
3	6	3	33.3
4	24	6	16.6
5	120	10	10.0
6	720	15	6.6
7	5040	21	4.7
8	40320	28	3.6
9	362880	36	2.8
10	3628800	45	2.2

INTRODUCING NEW VARIETIES OF PLANTS.

By CHAS. W. WARD, *Queens, N. Y.*

Before deciding upon the introduction of a new variety of plant the originator should have proven by practical test to his own satisfaction that the plant in question has at least sufficient economic or ornamental value to warrant its introduction. It should not be inferior to plants of the same general class already disseminated. When it comes to the introduction of commercial plants nothing should be sent out to the trade until its practical value has to some extent been proven. So far as the introduction of plants for the purpose of testing is concerned, it may be well held that any promising new and novel plant may be disseminated.

PRACTICAL METHODS OF INTRODUCTION.

Having decided that a new plant has given sufficient promise to warrant its introduction, the introducer should make sure that he has a sufficient quantity of stock in proper, healthful, and vigorous condition to insure his filling a reasonable demand with young stock in such condition that the purchaser has at least a fair chance of giving the plant a successful test. This cannot be done if the originator has but a small quantity of stock for propagating purposes and is obliged to force that stock in order to secure sufficient young plants to fill his orders. This results in what we term "over-propagation" and usually ends in general dissatisfaction all around. Many good varieties of new plants have been condemned because their constitutions have been ruined by over-propagation, and the purchasers did not have a fair chance to determine what their actual value was.

PACKING AND SHIPPING.

Having propagated a quantity of stock in first class condition ready for delivery, the introducer should make sure that in shipping all young plants are packed in the best possible manner so as to insure the purchaser receiving them in good growing condition and with the least check and damage during transit. The roots of young plants should be packed in damp sphagnum moss and wrapped in oiled or waxed paper which will preserve the dampness and prevent the roots drying out and the plant becoming shriveled. I prefer to pack all young stock in boxes sufficiently strong to insure against any damage from bruising or breakage.

DISSEMINATING SEED OF NEW PLANTS.

In introducing plants which are propagated from seed it would certainly be to the advantage of the purchaser as well as to the reputation of the introducer if the stock from which the seed disseminated is grown be carefully selected and rogued so as to insure seed being

gathered only from plants that approximate the fixed type and are in the best possible condition as to health and vigor. If the season for seeding has been an unfavorable one, it would well pay to have the seed selected out, discarding all light and immature seeds and sending out only well formed, heavy, and perfectly ripened seed.

PRICES TO BE CHARGED FOR NEW INTRODUCTIONS.

I am a strong believer in the general proposition that the plant-breeder who originates a new thing that bids fair to be of great economic value, is as fully entitled to a substantial reward and liberal profit therefor as is the inventor of any new mechanical device which is of great economic value. Therefore, I hold that the originator of a commercially valuable new plant should charge a good round price, commensurate with the care, trouble, and expense he has been put to in developing his production, and he should compensate the purchaser for the high price paid by delivering the very best stock that can be produced under the most advanced system of culture.

REPORT OF THE COMMITTEE ON BREEDING CARRIAGE HORSES.

By GEO. M. ROMMEL, *Chairman, Department of Agriculture, Washington, D. C.*

As Chairman of the Committee on Carriage-Horse Breeding of the American Breeders' Association, I have to report that I wrote members of the committee requesting suggestions and proposing the formation of a studbook as a subject for discussion. Replies were received as follows:

W. L. Carlyle, Ft. Collins, Colo.—I do not believe that the studbook proposition is one that is of any special importance for four or five years yet, until we get some of our stallions located and have some selected mares for registry that are going to be bred to them.

M. H. Tichenor, New York, N. Y.—The matter of a studbook for the American carriage horse is, I think, a very important one. It should cover the ground sufficiently for identification of the breed of horse. I don't believe in order to be entered a horse should be standard or standard-bred, but I do think he should be sufficiently strong; that it should have the official stamp, and should not be a mixture.

Charles F. Curtiss, Ames, Iowa.—I believe that a studbook should be established, but whether it is important or desirable that it be established immediately or not, I am not certain. Perhaps a better plan could be devised after a few years of preliminary work.

Prof. Curtiss also suggests that the classification for American carriage horses to be followed for the first time at the Iowa State Fair to be held in Des Moines in August, 1907, if adopted by other fairs and intelligently interpreted by the judges and fair authorities, would

afford the beginning of the means to fix the American carriage horse type. This classification is herewith submitted as a part of this report:

Class No. 2.—American Carriage Horses.

American trotting-bred horses of suitable size, conformation, style, quality, and action for heavy-harness service. Size, 15 hands and over—15.1 to 15.3 preferred. Entries in this class that do not measure up to a high standard of excellence will not be awarded a premium. Standard registry not essential, but exhibitors will be required to show pedigrees giving evidence of pure breeding. All entries in sections 15, 16, 20, and 21 to be shown in proper harness and hitched to appropriate vehicle. Conformation and action to count 70 per cent, manners 20 per cent, and appointments 10 per cent.

Section.	Description of animals.	1st premium.	2d premium.	3d premium.
13	Stallion 4 years old and over	25.00	15.00	10.00
14	Stallion 3 years old and under 4	25.00	15.00	10.00
15	Mare 4 years old and over	25.00	15.00	10.00
16	Mare 3 years old and under 4	25.00	15.00	10.00
16-½	Mare 2 years old and under 3	15.00	10.00	5.00
16-¾	Mare 1 year old and under 2	15.00	10.00	5.00
17	Mare or stallion foal	15.00	10.00	5.00
18	Stallion and 4 of his colts, any age	25.00	15.00	10.00
19	Mare and 2 of her colts, any age	25.00	15.00	10.00
20	Pair mares or geldings	25.00	15.00	10.00
21	Single mare or gelding	25.00	15.00	10.00

It is of interest that Kentucky horsemen are advocating the provision at their fairs of breeding classes for American carriage horses, and that the horse press is beginning to take up the subject seriously.

The work of the Department of Agriculture is progressing as rapidly as funds will permit.

One crop of colts sired by Carmon has been foaled, and a second is due this spring (1907). Private breeders are very much interested in the subject.

REPORT OF THE COMMITTEE ON BREEDING VEGETABLES.

By Prof. R. A. EMERSON, *Chairman, College of Agriculture, Lincoln, Nebr.*

As Chairman of the Committee on Breeding Vegetables, I submit the following report:

A hurried survey of the field indicates that the greatest needs along the line of practical vegetable breeding at present are, (1) to fix the types we already have, and (2) to produce new forms in case of a few vegetables where no existing form meets the full requirements of the situation. Two vegetables, cabbage and tomatoes, have been mentioned by members of the committee in this connection. There is need of a cabbage that shall be like Early Jersey Wakefield but which will stand longer. There should be a tomato of the type of Stone but much

earlier. The indiscriminate production of new sorts simply to produce something different, not necessarily better, is not to be encouraged.

To bring about the desired results in the way of producing new varieties for particular purposes, a careful study of existing varieties should first be made, to determine which ones come nearest to the desired type. Having determined this, the selection of individuals most nearly approaching the ideal and the crossing of the most nearly ideal individuals of the best varieties are the means to be employed in reaching the end desired.

As to the fixing of existing types, this is merely a matter of rigid selection of exact predetermined types. The trouble here is that there are no generally accepted standards for the different varieties of vegetables. The first thing to do, therefore, is to establish variety standards, so that seed growers and breeders will have some basis besides merely their own judgments upon which to make their selections. As a first step to this end, it is believed that an inventory should be made of all the varieties of vegetables in existence, together with a list of varieties in general use.

In addition to the encouragement of practical vegetable breeding as outlined above, there are some phases of theoretical investigation that should be undertaken. One of the most important of these is a study of the adaptation of vegetable varieties to various climates and soils. Even this question has a decidedly practical side in connection with the present practice of producing seeds under one set of climatic and soil conditions without regard to the very diverse conditions under which the seeds will be planted.

In addition to this outline of the work which should be done in the breeding of vegetables, the committee suggests that the work outlined here can be conducted by the United States Department of Agriculture better than by any other organization, and recommends that the matter be brought to the attention of the Secretary of Agriculture by the American Breeders' Association with the request that the work herein outlined be taken up at the earliest possible moment.

REPORT OF COMMITTEE ON BREEDING HORSE HYBRIDS.

By Prof. F. R. MARSHALL, *Chairman, College Station, Texas.*

It has not been possible to hold a meeting of this committee, and attempts to compare the ideas of the members upon a subject about which there is so little of certain knowledge, have been met with indifferent success.

The duties of this committee were stated to be as follows:

(1) To investigate and report on the possibilities, methods and technique of making improved hybrids by crossing the horse, ass, zebra, and other related species, with a view to producing a fertile horse hybrid draft animal; and (2) to encourage the production in large

numbers of a race of draft animals, long-lived, resistant to disease, sound in feet and limbs, strong and active, requiring a small amount of food, intelligent, teachable, agreeable in disposition, and comely in appearance.

So far as the members of this committee have been able to compare ideas on this subject, it is agreed that the most important part of the assignment is the investigation of the production of a *fertile* hybrid. For the present it would seem to be most wise to confine investigation to the hybrids of the horse and the ass. Results of such investigation would have great practical and great scientific value. Although there is some authenticated evidence that tends to show that there have been instances of fertility in horse hybrids, it is impossible at this time to locate animals of this class for which any powers of reproduction are even claimed.

It does not appear to be within the province of this particular committee to investigate the cause of sterility in horse hybrids so much as to attempt to locate individual animals that are in some measure exceptions to the rule of sterility. A small fund that would enable some qualified person to make examination of the reproductive organs of female mules that come in heat, not infrequently met with, would constitute an excellent basis for continued work in this line.

It is suggested that a fund be made available for the use of the experiment station in one of the leading mule-breeding States that will enable that station to secure such control of stock used by private individuals for breeding mules, as to permit of a large number of male mule colts to be matured without having been castrated, and to also provide for the collection of mare mules that give evidence of normal sexual desires. With such a lot of stock it would be possible to prove or disprove the possibility of producing a fertile horse hybrid.

METHODS IN SEED-CORN BREEDING.

By EUGENE FUNK, *Shirley, Ill.*

I wish to preface this report with a few remarks, not in extenuation of its contents, but rather in explanation of its brevity when the great quantity of accumulated data is taken into consideration. The work of certain individuals, and universities, I will hasten over. Not because of their lack of value, but because they are practically all doing the same work, with a few exceptions. These few exceptions are carrying the work beyond a certain difficult point beyond which the progress makers are rare. However, they stand out the more distinctly because of their scarcity. Experimental breeding in many different directions and for different objects have been carried on at different points in the United States since the score-card idea was launched on the corn producers of the corn belt. This new cult

found such favor with the laymen that corn shows and corn schools for its propagation were conducted at nearly every county farmers' institute. The score card, for selecting seed corn, served a useful purpose. In a general way it helped the farmer to better his seed to a marked degree, but it has without doubt had some ill effects. The score card rivets the attention on apparent qualities with absolutely no heed to the inherent qualities. Of what value can the apparent qualities of an ear of corn be other than that of capacity and maturity?

With the advent of the ear-to-row system, a great many corn growers turned so-called corn breeders, and with the score card in mind, selected ears for breeding purposes. Their work was earnest, and probably in some instances performed with accuracy. But the selection of score-card ears from best rows, and a continual repetition of this method, carried only to this point, did not produce expected results. And the final result was this—a great many who had not the fundamental knowledge of plant breeding, proposed to breed corn, and became confused because of no score-card results from the ear-to-row method. Consequently, in some cases, a reaction set in; and some being convinced of the value of the score card, condemned the ear-to-row method. Others were faithless to the ear-to-row method, because succeeding years did not fulfill promised results.

I do not wish to be understood as wholly condemning the score card, for its early service of creating a widespread interest in a vital subject was indeed beneficial; but it has served its purpose. Its usefulness is to the corn grower. Corn breeders should have naught to do with it. In my service as superintendent of the corn judging contest at the International Live-Stock Exposition, I had the opportunity of listening to the reasons given by corn judges for placing one ear above another in the scale of excellence. In many instances all reasons given there were practically valueless from a utility standpoint.

In gathering information for this report I was struck with the widespread interest in corn improvement, and the resulting benefit.

There is undoubtedly great improvement being made in corn. From east to west, wherever corn is grown, there is a vigorous striving for better seed. With the proper guiding light for this energy the results could be made much more emphatic than they are at present.

My inquiries into the methods employed in breeding, the improvement made, and the results that were being worked for, were made by a letter containing 12 questions, the answers to which would give me some definite knowledge of prevailing conditions. These questions were substantially as follows:

(1) How long have you been growing corn?
(2) How long have you been breeding corn?
(3) What varieties do you propagate?
(4) Do you conduct a breeding plat?
(5) Do you plant in a plat an ear to the row?
(6) If not, what system do you follow?
(7) Do you conduct more than one plat for one variety every year?

(8) Have you practiced crossing different varieties?
(9) What have been your results of the above?
(10) Do you detassel any of your rows? Entirely or in part?
(11) What are the most striking results you have obtained?
(12) What one result do you strive for above all others?

My answers were most surprising. Some corn breeders of more or less reputation would have nothing to say as to breeding methods. Some would condemn one method, while others would praise it. Some showed very scant knowledge of any breeding methods. Many were discouraged with breeding plats. In answering the question about detasseling, one breeder, who sells, according to his statement, 3000 to 4000 bushels of seed corn a year, answered that he detasseled his entire plat!

The last two questions, as to improvement already made, and as to the most important point to be worked for, brought forth the fact that the score card or some other influence is leading many of these corn breeders astray. No one can dispute that the first and greatest of all objective points must be yield. Yet not one in five would mention yield in answering either of these questions.

Many new varieties it seems have been produced by crossing established varieties. However, it is my belief that any improvement made in this way could have been obtained to a greater extent by following a certain breeding method within the variety.

I am convinced that at certain universities methods are being employed that will sooner or later give tremendous results.

In conclusion I wish to suggest a National Registry Association. Some 20 men who are doing the practical and beneficial work must get together and endorse a system of breeding and formulate a plan for registration of varieties that have a performance record behind them.

NEED OF PUREBRED STOCKS OF ANIMALS IN THE SOUTH.

By Prof. C. A. CARY, *Auburn, Ala.*

In the South the breeding of purebred animals has not received attention according to its importance. This is due in part to the paucity of purebred animals and in part to the single-crop (cotton) system of farming. Changes are coming, and the South will and must become a great factor in the live-stock world.

A few farmers have embarked in the beef-cattle industry, and since 1900 more purebred Shorthorns, Herefords, Angus, and Devons have been brought in to that part of the South lying east of the Sabine river than ever before in its history. It is true that many of these animals have been bought by inexperienced men and upon a pedigree without having been seen by the purchasers. Consequently many of

the "culls" from Northern herds have found their way into the South. Moreover, this accounts for many cases of failure and indifferent success. With experience has come knowledge and the farmers' institutes are educating the farmers to higher ideals and better methods. There is great need for many more purebred beef herds in every Southern State.

The dairy herds of purebred cattle are confined almost exclusively to the Jersey breed. While there are a few registered Jersey herds of high quality and rich breeding, there are others which fall below the average Jersey standard. Possibly as many highly bred Jerseys have been brought into the South during the past forty years as in any other part of America of equal area.

But why is not the South furnishing its share of purebred Jersey cattle to world buyers? Largely for want of cooperation. Had the early Southern Jersey breeders united and kept up a fairly good system of selection based upon actual production of milk and butter (keeping their own company or cooperative association registration books) they would now have a corporation or trust with a "corner" on some of the richest Jersey blood in the world. You may hear men say that the South is not a beef country, but it is an established fact that the South is an ideal place for the Jersey. There are more good Jersey grades in the South than in the North, East, and West.

Saddle and light-harness horses have been bred in the South for years, but the farmers as a whole cannot afford to breed such horses. Farmers must have largely the motor horse—one that can plow, draw machinery, or haul a wagon. As a rule a farmer cannot afford to breed a race of horses that cannot be used on the farm. In other words, a farm should produce the horse power required to run the farm. At present there is no animal that will give greater returns for the money invested than the dam that will produce the heavy mule. We talk about cattle selling at 7 to 8 cents and do not realize that mules sell at 20 cents per pound and it costs no more to raise a mule than it does a steer. What the South (cotton South) needs is the long-bodied, long-necked, big-headed, long-eared jack and the draft dam that will give body to the mule she produces. Henry Clark, of Wartrace, Tenn., says the Percheron mare is the best dam for producing mules. If this be true, the cotton belt of the South must have such a draft mare; because Tennessee and Missouri can no longer furnish sufficient mules for the cotton, sugar, and rice plantations of the South and also supply the West Indies, Mexico, Central and South America. Hence the South must have the mule jack and purebred and grade draft mares. In order to get such dams, purebred draft stallions and mares must be brought into the South and highly bred grade draft mares must be grown to supply the home demand for mule dams.

It is scarcely necessary for me to say that the South is the country beyond compare for the production of the finest bacon hog on earth. We need more Tamworths, and Berkshires, and possibly the large Yorkshire.

Sheep breeding is sadly neglected. The mutton sheep and particularly the Christmas lamb can be made in the South. The Shropshires, Southdowns, Dorsets, etc., will do much toward bringing up our native flocks. The great aim should be September lambs to be pushed for a Christmas market.

Now is an opportune time for southern experiment stations, agricultural colleges, and commissioners of agriculture. Every Southern State and possibly every county should be organized into a breeding association for profit and for development of special-purpose and type animals. There should be no open go-as-you-please organization. Let there be an iron-clad agreement that the best shall not be sold, but kept within the organization. Of course, there are other rules and laws to be followed explicitly and the plans suggested by W. M. Hays in his series of articles on Breeding Animals and Plants that appeared in the Breeders' Gazette might serve as a working basis.

But why should this work be commenced now in the South? The breeders are few and they could readily unite. Moreover, the live-stock industry will and must grow in the South during the next decade more rapidly than ever. Consequently there is no possible chance for a decrease in the home demand for many kinds of purebred live-stock.

Suppose a Shorthorn breeders' association should be formed in Alabama or in a given part of Alabama. Just now it would contain only a few men. Let them organize for a period of 25 to 50 years. Let them select for a definite purpose, such as the dual-purpose Shorthorn. Let every breeder be compelled to breed to a selected end or purpose. Let no man sell the first, second, or third best of his herd in bull or cow except as permitted by the association. Let there be rules by which the best bulls may be shifted from one herd to another in the organization. In 25 to 50 years this organization would have a trust in truth and in fact on that special type of Shorthorn. In order to launch and perpetuate such an organization, there must be a union of the scientific man, the business man, and the practical man.

REPORT OF THE COMMITTEE ON BREEDING FIBER CROPS.

By L. H. DEWEY, *Chairman, Department of Agriculture, Washington, D. C.*

Practically all that has been done in this country in the breeding of fiber plants is included in the seed selection begun under the direction of W. M. Hays' direction at the Experiment Station at St. Anthony Park, and the selections made by Prof. Bolley at the North Dakota Agricultural College. I have full information as to the type of flax plants desired for the production of fine spinning fiber, and also the type desired for the manufacture of binder twine. These types are now produced by seed imported from Europe, and not grown more than two or three generations for fiber production in this country.

No attempt is made in this country to maintain the type or to breed up better varieties.

What has been said about flax applies in general to hemp also. The best types of hemp are grown from seed of the second or third generation from China. The quality of Kentucky hemp is kept up by repeated importations, in small amounts, of Chinese seed. So far as I am aware, no attempt at selection of hemp seed has ever been made in this country.

IMPROVEMENT OF CITRUS FRUIT VARIETIES.

By E. J. WICKSON, *Chairman, College of Agriculture of the University of California, Berkeley, California.*

The possibility of improvement of varieties of citrus fruits is obviously conditioned upon opportunity manifesting itself in desirability of different types, forms and characters from those now familiar to the commercial or amateur grower. It is idle in this stage of the advancement of citrus fruit production in California simply to indulge in a general exhortation of improvement or to suggest that change is desirable because it may secure something different. It is also true, as may be insisted upon later, that radical changes in the characters of varieties, which citrus plant breeders are attaining in the eastern and southern states, are not necessarily of any local value to California, and, from our point of view, may not constitute any improvement at all. We have followed a long and devious path of our own toward the excellence which we now possess and reference to it may be instructive to newer Californians.

It was my privilege as a young man to participate in the citrus fairs which were strong promotive and directive agencies in the early development of orange and lemon growing in Southern California. I remember the first held in Riverside nearly thirty years ago. Recent comers cannot appreciate the eagerness, the effort for close and correct discrimination, the enterprise to secure everything which had promise in it and to bring it to judgment, which were characteristic of the arguments of Riverside and of the rival citrus colonies who ransacked the world to secure the golden fleece, not of Kolchis, but of citrus excellence which should prove effective in the success of their unique horticultural enterprises. The result of this world-search brought oranges and lemons from China, India, Persia, the Mediterranean islands and countries, the gulf coast of the south, the West Indies and Mexico, and from far and wide through Oceanica, until there existed in Southern California thirty years ago a larger collection of citrus fruit varieties than in any other single country under the sun. How the visitors at the fairs admired and praised; how the judges at the fairs analyzed and condemned them by dozens, reserving only a few for tentative favor. Praise was most from the idle; merciless criticism

was the only protection for those who were striving to lay the foundation for a livelihood and a competence. And so the motley grow of citrus varieties began to fall before expert judgment which, it must be acknowledged, was strikingly accurate and impartial because those who were called upon to execute it were trained to quick and broad conclusions through their previous participation in commercial, financial, educational and other professional affairs. The men and women who achieved the success of the citrus colonies of Southern California possessed probably a higher order of intelligence and a richer experience than were ever summoned to a single agricultural undertaking before.

Individual and committee decisions and growers' early results saved a few of the scores of varieties of oranges and lemons for wider and longer trial. Local pride intruded measurably also. Each district was willing to send its champion to tilt for the awards so long as chance remained to it, and local names were proudly given. Let me call the roll to awaken the memories of the pioneers: "Asher's Best," "Wolfskill's Best," "Mayberry's Premier," "Baldwin's Favorite," "Wilson's Best," "Kercheval's Queen," "Riverside Navel"—these were some of the names to conjure with for prizes twenty-five years ago, because all these appealed to local pride and loyalty. There were a few more of general growth at that time, but they were neither here nor there. Out of the throng came one to survive, the Riverside Navel; but to become the universal champion it must forsake its early advocates and promoters and stand forth the Washington Navel orange of California.

I am indulging in these historical references to emphasize a fact which seems to me of ruling importance in this discussion and that is that California has attained to singleness of purpose in the matter of citrus fruit varieties by a rigid and long continued process of selection, beginning with pioneer growers, following with pioneer traders and shippers, following again with analytical chemists, consumers and the general development of commerce and investment—every phase of it exercising the principle of selection in its own way, until, on the basis of its quality and characters and the wealth produced, the Washington Navel is the greatest orange in the world, which it was the dream and ambition of the pioneers to attain by their devoted and discriminating effort.

In order to be a little more specific as to the progressive rejection of varieties once esteemed, let me refer to records which I keep of the kinds which in any year seem to command attention of large commercial planters. The following is the number of such varieties in each of the recent years named:

	Oranges.	Lemons.
1890	22	9
1900	8	5
1905	2	3

I disregard in all years a few varieties which are either untried or appeal only to amateurs or are special types which certain growers plant in a small way for special trade. The two oranges which stand large are, of course, the Washington Navel and the Valencia Late: the three lemons are Eureka, Lisbon and Villa Franca, the first being greater than the other two combined and becoming relatively greater. There are, of course, more varieties of oranges and lemons commercially grown and they have some distinctive values which may bring them revival, but the contrast is limited to those largely planted at the time stated.

It may be taken as established that close and long continued selection has given us two varieties which are of acceptable type and that these types are not to be wisely departed from. Each, however, is susceptible of improvement and it is interesting that each has its strength and weakness. In an effort during the last year to secure the conclusions of experienced growers and propagators as to what remained to be desired in the way of commercial varieties of the orange, I received the following replies from many different people, which I condense to a single declaration as follows:

A later Washington Navel, to be good after May 1st; an earlier Washington Navel, to be good before January 1st; a Washington Navel that will hang on the tree like the Valencia; that will not crack on the tree; that will stand hot sun better; that will be free from puffing, as the Valencia.

A Valencia that will not turn green after maturing; a Valencia that will bear more regularly.

A large seedless variety to bridge the gap between the Washington Navel and the Valencia, and displace seedlings ripening at that time; also a variety that shall be as good as the navel and late as the Valencia.

Here we have each variety described, in part, in the terms of the other, and new varieties described in the terms of both. It is very clear that we have come to a definite attainment of what is desirable in a commercial orange for our California purposes and that whatever we do for improvement should include no serious effort to break from this type but rather to enforce it upon any disposition toward variation.

Practically the same condition prevails in our approved varieties of lemons, for the following are described as desirable improvements:

Increased disposition in the Eureka and Villa Franca to bear summer fruit and with resistance to frost like the Lisbon: a Eureka with more uniform shape, smoother skin and color like the Lisbon: a Lisbon with fewer or freedom from thorns like the Eureka.

In lemons then, no departure is needed from the type which has been determined by selection hitherto, but there may be new characters within the type. Before final suggestion is undertaken concerning this effort a brief reference to the assurance that we have correct types for our purposes may be pertinent.

The Washington Navel orange as it goes from California into the world's commerce is a combined product of grower's skill and climatic conditions operating upon its own natural qualities and characters. Neither of these factors alone could achieve its present position. The navel mark is neither peculiar to it nor determinative of it, for there are other navels which are inferior here and our navel is inferior elsewhere—even in Behia, whence it came, it has no such quality and standing, because in coming to California it passed from humid, tropical to an arid, semi-tropical environment. The tropical orange is not in the same class with the semi-tropical from the point of view of commerce. Trade in tropical oranges is local or limited: trade in semi-tropical oranges is world-reaching. The orange produced in an arid, semi-tropical climate is dense and compact, firm and better in keeping and carrying characters. It is also of more sprightly flavor and richer composition. Those who are disposed to exalt the humid-air orange for superior sweetness forget that the California orange, as compared, for instance, with the Florida product, has not less sugar but adds to it more acid; being, in fact, not less sweet but more sour. In both sugar and acid are nutritive substances, the superiority of the California fruit from a dietary point of view is clear. Such an orange, enclosed in a thin skin of silky texture and beautiful finish, comes very close to an ideal upon which to found an industry. How well such a type of orange serves that purpose is shown by a production for 1906 estimated to have reached a selling value of twenty million dollars—the greatest value ever attained by any state or nation in the citrus line, and delivered to purchasers at a greater average distance than any other ever attempted. Far less in degree but similar in kind has been the development of the California lemon industry; and though its greater difficulties have been by no means overcome, the advancement in the attainment of suitable varieties has secured something suitable to build upon, as already shown.

The improvement of citrus fruit varieties as diligently pursued by expert plant breeders of the United States Bureau of Plant Industry and of the southern experiment stations is of great pomological interest and promise generally. The objects aimed at, are, however, of rather remote applicability to California because the conditions to which they endeavor to adapt their new fruits of citrus origin do not exist within the range of our large commercial citrus industry. They are endeavoring, by hybridization to induce a combination of maximum hardiness with quality by which, through selection, they may attain something at least tolerable from an amateur's point of view. They wish to produce something like an orange or like a lemon which can be grown under what are now found to be non-citrus conditions. They are inviting the most startling changes of types of citrus fruits, that some departures may fall on their side. To the Californian the work is interesting. Even if they should fail to secure an orange which would bear fruit in Pennsylvania, they may produce orange blossoms and thus minister to a charming requirement even of northern people.

But although California has no need for such changes of type in citrus fruits and has, as shown, worked so diligently and long for the attainment of the types which are at present supreme in her industry, there is still ample opportunity for improvement within the types. Such improvement is to be attained not by hybridizing, but by selection—the very effort which has opened the way for California progress hitherto. But why need this work be pursued differently now?

In the first place the citrus interest of California is too great in its commercial and cultural problems and responsibilities to serve itself pomologically as it did at its beginning. Second, the improvement of a type, removing its defects and adding to its excellencies, requires closer work than to recognize the type itself and found an industry upon it. It requires the most acute perceptions of minute characters and tendencies, and most diligent search for them. It necessitates the determination of what is absolutely the best in form, substance and finish, vigor and productiveness, and the conditions under which all these are attained. It invites the closest pursuit of the best fruit as it appears in packing house or exhibit, or as it secures special price and fame in the trade, to the trees whence it comes. Its subsequent steps are analysis, measurement, comparison, photographic and written records and study of environment including culture, and the best possible discernment of the relations of all these determinations to each other. The supreme test is propagation under various conditions to test constancy and the last resort is multiplication that the whole industry shall have the advantage of the best thing there is of its kind to plant. Incidental to the foregoing is the test of stock on which such trees are to grow; which stocks are best for this or that, or here or there, and how has it been demonstrated?

Such work will require the services of the best trained and most expert men in pomological science. They must have good eyes and clear heads, not too much cumbered with other affairs, and they must have full knowledge of why they seek and quick recognition of the signs of appearance.

It is to secure advanced work of this kind that alert and influential orange growers at Riverside appealed successfully to the legislature of 1905 for the provision of a special Citrus Experiment Station and made a tender of valuable land for it which is now being improved, for the purpose intended, by the Experiment Station of the University of California. It is designed to be the home for such important pomological work although many other cultural phases and experimental problems of orange growing will naturally be associated in its effort. Our meeting at this time is for the purpose of marking its beginning along its designated lines. It is eminently appropriate that we should assemble for this purpose in Riverside and almost upon the very spot where the first citrus fair of the pioneers marked the first great break towards the attainment of the world's high mark in commercial production of citrus fruits which now belongs to California.

REPORT OF THE COMMITTEE ON BREEDING FISH.

By J. W. TITCOMB, *Chairman, Bureau of Fisheries, Washington, D. C.*

The fundamental principle involved in the hatching of fishes begins with the fertilization of the egg, which under natural conditions may be compared in simple language to the fertilization of flowers, the water acting as the agent of transmission of the fertilizing agency as the insects, wind, etc., do with the flowers.

The egg is to the fish as the seed is to the plant. The seed of the plant is not complete until it has been united with the pollen. Bees and other insects when in search of honey shake off and carry the pollen, bringing it into contact with the seed. The milt of the fish corresponds to the pollen of the flowers but instead of insects to carry it to the eggs this duty is performed by the water.

In the artificial propagation of fish the ripe eggs are expelled into a receptacle which has been dipped in water and allowed to drain. The milt of the male is then expelled into the same receptacle. The fertilizing agency is thus brought into direct contact with the eggs, resulting in a much larger percentage of fertilization than ordinarily occurs under natural conditions.

It has been assumed that the duties of this committee consist in utilizing the existing knowledge of fish culture in efforts to improve the breeding of various species of fish by the usual methods employed in improving the breeding of various domestic animals. That such improvement is possible was long ago demonstrated but the results of such attempts seem to have been confined largely to fancy fishes, notably, the goldfish, the natural color of which is a pale green. In other words the fancy goldfish of commerce is the result of breeding for color, for shape, and for variation in fins. Some of the results in this direction have been very remarkable.

In Japan there is a golden carp, a production of breeding by selection from the ordinary carp. It attains a length of two or three feet and is bred as an ornamental fish. The golden ide and golden tench may also be mentioned as examples of breeding for color, the natural color of the species being of a greenish hue.

For the purpose of this report fish breeding or fish culture as now conducted may be classified as follows:

1. The propagation of the commercial fishes the eggs of which are obtained from ripe fish caught by the commercial fishermen in connection with their regular operations and fertilized with milt from male fish caught in the same manner.

2. The propagation of commercial fishes the eggs of which are obtained from fish caught previous to or during the spawning season especially for fish cultural purposes, and with the exception of the Pacific salmons liberated after their eggs have been taken and fertilized.

3. The propagation of the various trouts either by the maintenance

of a brood stock under domestication or by the capture of the fish when on their way to the spawning grounds. In the latter case the fish are always liberated after the spawn has been taken and fertilized.

4. The breeding of fishes by intensive pond culture so-called, in which case the fish are allowed to nest and deposit the eggs and milt naturally.

In the first class may be included such fresh water species as the pike perch, whitefish, lake trout, and the anadromous fishes like the shad, striped bass, and white perch. The various marine species now artificially propagated may all be included in this class. The numbers of these fishes annually propagated and distributed by the federal and state governments run into billions and represent the hatching of eggs which would otherwise go to waste.

Owing to the cannibalistic nature of the various species mentioned above and also to the wholesale method by which they are handled, it has been found impracticable to attempt to rear any of them and all are planted as fry so-called, on or before the absorption of the umbilical sac. All of these species begin to prey upon one another when confined in an artificial hatching apparatus or retaining tanks beyond the period of absorption of the umbilical sac.

As an illustration of this cannibalistic tendency the white perch is selected as an example, the occurrence having been recent and under the observation of the officials of the United States Bureau of Fisheries at Washington, D. C. Approximately 400 white perch fry ten days old were placed in an aquarium of ample proportions and supplied with constantly running water. They were fed on daphnia or water lice and were seen to take them greedily. When 21 days old the appearance of the aquarium indicated that the full number of fry were not present, and upon examination one little fellow under a half inch in length was discovered swimming about with one of his mates more than half swallowed. The two together weighed 1-50 of a gram. During the following days many more of the fry disappeared, and as the outlet of the aquarium was screened by two thicknesses of cheesecloth and no dead fry were removed, it was apparent that the disappearance was entirely due to cannibalism. In seven weeks, notwithstanding the fact that the fish were fed daily, only two remained, and not more than a dozen dead fish had been removed. At the end of two months only one remained to tell the gruesome tale. The sole survivor when eight weeks old measured 1½ inches in length and weighed 1¼ grams or 62½ times the weight of the three-weeks old cannibal and his victim.

In the second class may be included such valuable commercial species as the Atlantic salmon and the various salmons of the Pacific coast, for which there are no commercial fisheries at the times and places where the fish naturally spawn. The Atlantic salmon are obtained by purchase from commercial fishermen who capture them in weirs when they enter the Penobscot river for spawning purposes. This run of fish usually occurs during the months of May and June and it is necessary to retain them in ponds until autumn to ripen.

They are then stripped and their eggs fertilized after which they are liberated and allowed to return to the ocean.

It may be proper to note that at the present time the Penobscot river is the only tributary of the Atlantic ocean in the United States which is frequented by the Atlantic salmon to a sufficient extent to maintain a commercial fishery, its disappearance from other streams having been caused in the advance of civilization by deforestation, artificial obstructions, and the pollution of waters. The maintenance of the Penobscot salmon fishery is entirely due to artificial propagation, few if any adult fish ever reaching the natural spawning grounds.

When caught by commercial fishermen the Pacific salmons are unripe and cannot be confined in inclosures at the points of capture. It is therefore necessary to intercept the fish in the upper waters of the rivers frequented by them during the spawning season. They are thus obtained when actually ripe or nearly so, and their retention for a few days does not seriously impair the quality of their eggs.

In connection with the breeding and rearing of the various species of trout there is no commercial fishery upon which to draw for eggs. The obtainment of eggs of these fishes necessitates the maintenance of a brood stock or the capture of wild fish on their natural spawning grounds or when they are en route thereto. It is possible to domesticate all of the various species of trout now propagated, and therefore in many instances brood fishes are maintained at the hatcheries. Not only is it an easy matter to assemble a brood stock of wild fish taken from various streams and ponds, but at certain stages of development the eggs obtained therefrom can be transported on journeys of several weeks duration.

In the United States there are many breeders of trout for commercial purposes depending entirely upon domesticated stock for their supplies of eggs and whose surplus eggs are sold for stocking many hatcheries in addition to their own.

The various species of the fourth class, notably the basses and sunfishes, are all subject to domestication and the same brood fish can be used for a number of years without deleterious effects.

The artificial propagation of the black bass, by taking and impregnating the eggs, has not been practically successful up to the present time. The eggs can be stripped only with great difficulty and it has been necessary to kill the male to obtain the milt. Another obstacle is the difficulty of obtaining eggs and milt at the same time, even when the fish are taken from over the nests when apparently in the act of spawning. Interruption or handling seems to prevent the discharge of eggs or milt.

Since a practicable way to artificially impregnate the eggs of the bass has not yet been developed, and the handling of eggs with indoor apparatus is impossible, it is fortunate that the natural impregnation of these fishes reaches a percentage closely aproximating that which fish culturists have been able to secure by artificial means from other species, and also that the parental instinct is unusually developed.

It will be seen from the foregoing classifications that it is impracti-

cable for this committee to undertake any work with the various species of fish propagated under Nos. 1 and 2 even were it possible to use all the existing facilities connected with the propagation of fish at the disposal of the federal and various state governments.

With reference to the third class it may be stated that much progress has already been made in the knowledge of trout breeding. At the present time there are in this country approximately 35 breeders of trout under domestication for commercial purposes, some of whom have made a special study of the food best adapted to rapid growth with the view of producing a palatable fish in conjunction therewith. As the trouts can be placed entirely under the control of the breeder, and as it is a simple matter to obtain and fertilize eggs of wild trout, it will be seen that it is not difficult to breed for virility or for certain distinctive features or marks. However, fish under domestication lose to a certain extent the vivid coloring and markings of their wild progenitors.

The experience of fish culturists has fully demonstrated that it is possible to breed trout by selection of stock for rapid growth and for weight to a certain extent. It is undoubtedly possible to breed trout for peculiarities in marking and color, as well as for richness in color of flesh, the latter varying from pure white to a very rich salmon shade.

Experiment in hybridization have been conducted almost from the inception of modern fish cultural methods but with few, if any, economic results. In most instances hybridization of two species produces a sterile fish. Undoubtedly the crossing of the various species of cut-throat trouts and others in which the variations are so unimportant as to almost warrant describing them as subspecies instead of distinct species will produce a virile hybrid or cross, and by this method it may be possible to make an improvement in the stock.

With the basses and other fishes propagated by intensive pond culture better results have been obtained by the frequent introduction into the ponds of wild fish rather than to depend upon successive generations of domesticated stock. The possibilities for experimental work in breeding do not offer so large a field in pond culture as in trout breeding.

The committee on breeding fish has not been organized for a sufficient length of time to be able to report any experiments initiated by it but it is hoped that as a result of future efforts in this direction a more definite report of economic results can be made at a later date.

Owing to the fact that the fish cultural stations now operated by the various states and by the federal government are taxed to their utmost to produce fish for supplying applicants, experiments along the lines which this committee suggests have been slighted and in the planning of fish cultural stations experimental work has not been taken into consideration.

A few elementary experiments which have already suggested themselves to the committe have shown the great lack of facilities for doing

such work. Such experimentation naturally devolves upon the federal government.

It is therefore hoped that at no distant date the federal government will appropriate money for one or two fish cultural experiment stations to be operated along somewhat the same lines as agricultural experiment stations. The cost of such stations will undoubtedly exceed considerably the cost of an ordinary fish cultural station as now conducted but the economic value of such experimental stations from the results which ought to be obtained is sufficient warrant for the increased expenditure.

NOTES ON BREEDING OATS.

By J. B. NORTON, *Washington, D. C.*

Oat breeding in the United States in general is a question of breeding for resistance. The pure factors leading to increased yield are of paramount importance only in those regions where the optimum conditions of soil and climate always prevail, that is, we have to consider other things besides the possible yield per plant as determined by the number of flowers and the size of grain. With these factors alone, breeding work would be a simple question of mathematics.

In actual practice these two points are crowded into the background by the question of resistance. Rust, smut, lodging, hot weather, drouth, poor soil, and a multitude of other adverse circumstances all go to influence the yield and must all be considered in selection work.

The fact that a plant or strain of plants does not succumb by adverse conditions such as disease, drouth, etc., has been interpreted as resistance. As a matter of fact this apparent resistance may be due to quite different causes in different plants. These different causes lend themselves to a somewhat fixed classification as follows:

Physiological resistance to disease and parasitic and predatory enemies is usually and probably correctly assigned to the presence in the plant of some substance, that while it does not prevent the initial entrance of the disturbing factor, yet prevents the full development of the disease or organism.

Morphological resistance includes those cases where attack is prevented by denying entrance to the parasite or disturbing factor through some structural adaptation, also where effects of injurious environment are overcome by definite structure, as in drouth resistance, resistance to lodging, etc.

A third class in which plants escape disease and adverse conditions by modification of the growth period, while of great value in breeding work, yet can hardly be included in true resistance. If an oat variety ripens before the attacks of rust can hurt it, it is not necessarily resistant and can be said to be only rust escaping. This class of phenomena is in a way related to morphological resistance and the two can be more properly grouped as avoidance rather than resistance.

In all these cases we have resistance or avoidance in varying degrees and hence the necessity of selection of the best types enters as the great problem of breeding.

SMUT RESISTANCE.

Apparent smut resistance was noticed for several seasons but not studied carefully until last year when the marked difference in resistance of strains that had been untreated for several years showed some selections to be absolutely free from smut, while others growing near them were smutted about twenty per cent. This resistance is most marked in Early Burt and some of its hybrids, one whole series being perfectly free from smutted heads. Early Champion and its selections smutted worst. In the plats last year, without considering other characters, selections and hybrids, of this variety could be easily picked out. The cause of resistance to smut is not definitely known but it is probably physiological.

RUST RESISTANCE.

Leaf rust is usually most prevalent on varieties derived from *Avena fatua; Avena sterilis* forms are nearly free from it. Stem rust, however, attacks the latter very badly. In breeding for resistance to smut the yield of grain is probably the best basis for selection.

The variety studies and attempts at classification of standard varieties has brought out the fact that cultivated oats have originated from more than one wild species. It has been generally accepted that *Avena fatua,* the common wild oat of Europe and Asia, is the progenitor of all our cultivated forms. Such, however, is not the case. The red oats of the South and some related forms are undoubtedly descended from *Avena sterilis* of the Mediterranean region. This is plainly shown in a habit of growth, that of a semi-winter annual the fact that in *sterilis* alone we have the firm union of the first and second grains in the spikelet, in the color of the flowering glume and of the basal hairs, also in the reversionary forms which appear in second generation hybrids when a red oat is one of the parents, in many cases the hybrid bears a striking resemblance to *Avena sterilis.* Many other points of resemblance and habit, etc., have been observed. It is probable that a third wild species is represented by the common Burt oats in the southern states.

HOT WEATHER BLIGHT.

One of the most serious conditions interfering with successful oat growing in the United States is the blighting effect of hot weather on the flower and embryonic grain. Under normal weather conditions at blooming time every flower should set a grain and if the weather remains right, all these grains should develop. Such, however, is rarely the case. To a certain extent oat varieties have a definite blooming period which is only partially influenced by the time of planting. Oats planted in Illinois about April first ripened less than a week

earlier than the same varieties planted May first. Winter varieties, like Virginia Gray, planted in the fall will be ripe before the same seed planted in the spring has bloomed. Red Texas and similar *sterilis* varieties last year behaved peculiarly on account of a prolonged drouth. Ordinarily they ripen just after Early Champion, but last year Early Champion and the other *fatua* forms matured at their proper time while the *sterilis* forms, which probably originated in a region subject to drouth, refused to bloom until nearly a month after their normal period.

Selection in this case is rather easy as it involves two quantitative variants, the per cent of filled grain and the weight of grain per plant. The factor of earliness seems to be connected closely with any resistance to this hot weather blight but many hybrids between late and early varieties indicate that this is only an accidental relation and not true correlation.

In conducting breeding work, the first point to be considered is the climatic region for which the new strains are to be produced. In corn growing, the earliest varieties come from the north, while in oats the reverse is true. This is due to the fact that the growth limit in oats is determined by hot weather instead of by frost, as in corn. A late oat, such as White Russian or Black Tartarian, which might outyield all others in the north, when transferred to Kentucky, would not fill on account of the hot weather. In view of this important point, it seems advisable to carry on oat breeding work as a local proposition. While one central station for general work in hybridization and methods can be established, the final testing of selections, etc., must be done under the definite local conditions to reach the best results.

To secure pure strains of high average yield intended for any definite locality, it is not necessary to keep an extensive set of descriptive notes. Take for example, the conditions found in Central Illinois and Iowa where oats are grown as a rotation crop with corn. The one factor to consider here is the net average yield of the marketable threshed grain. In planning for this work the following points should be considered:

First, foundation stock. As many so-called varieties as possible should be tested in small rows for general adaptability to regional conditions. The most popular local varieties can be used to start preliminary selections. The breeder will not be far wrong in using these as a basis for preliminary work. They are probably composed of mixtures of several distinct types, many of which will outyield the original mixture.

In carrying out pure selection work, it is essential for the best results to work with large numbers. This is especially true in self-fertilized crops where no great change can be expected from continued selection. Unless a race varies, the value of continued selection is lost and we find ourselves selecting plants that are large through some effect of local conditions, size of parent grain, etc. Any increase obtained by this *maxima* selection will be lost as soon as selection ceases, as it must in the case of small grains. It is of great import-

ance, then, that we look for the original good plants in the field of the parent variety.

It is not necessary that a foundation bed be established with the grains planted a definite distance apart. The one requirement is that the original selections be made from plants grown under as near field conditions as possible.

The best criterion of a good oat is that it will do well under the conditions that it will have in the field. We do not know what the characteristics of a good breeding plant are. The ability to produce the greatest average *value* per acre is the criterion of the best strain of oats for any given set of conditions. Value is made up of a combination of *quantity* and *quality* where quantity counts about 90 points. Quality can be definitely measured and its factors determined, but quantity is made up of so many varying factors that we are at sea when it comes to general directions for selection. Where we desire a definite type of plant, as a Black Side oat, Swedish Select, or Sixty Day, the problem is easier. The typical plants in these varieties are closely related and any two type plants will give about the same progeny yield and will agree in their general form and behavior under different conditions. In making original selections for breeding work, the regular field is just as good as a few thousand plants in a foundation bed. In picking out several hundred of the best plants from a half acre you are sure to get just as good stock as if you picked from your foundation bed.

The next year plant the grains from the best head of each of your select plants in a series of short drilled rows of equal length, say five feet long and twelve inches apart. When these progeny rows mature, discard those that are least resistant to drouth, rust, smut, lodging, etc., harvesting only the best. This should be threshed and judged for quality, and if desired, for yield in a general way. No accurate estimate can be made but many rows can be eliminated on account of their poor yield. If any row shows lack of uniformity in type, it should be discarded at once. The seed not saved for the next season's planting can be used for an increase plot for home seed, as it would be better than the general field average and of reasonably pure type. Any selections from this increase field in the future will probably result in a waste of time and hence should not be made.

The seed for the second year's crop is planted in rows 17 feet long and one foot apart for a yield test. This is such a fraction of an acre that by multiplying the yield of the row in ounces by five, we obtain the approximate yield per acre of the selection. This system of yield estimate gives much better comparative values on a uniform field than half acre or acre plots. The conditions can be more closely controlled, rows influenced by extra good soil conditions can be more easily noted, and if necessary thrown out. The experimental plot is smaller and can be more easily cared for. With the amount of seed at our disposal, the results can be checked up by duplicate plantings.

In the third year, seed of the best selections can be sown in larger plots of uniform size for increasing the amount of seed.

In estimating yields of small rows on even ground, a check row should be planted at definite intervals. This seed should be obtained by carefully mixing equal quantities of extra seed from several or all of the selections when there is a difference in the ripening period. This will give the most reliable check, as it will be subjected to all the varying conditions of weather affecting the different selections. A check composed only of early oats would be unfair to the later strains and vice versa. In harvesting rows for yield, take only that portion of any row that would be cut by a binder, otherwise easily lodged varieties would be given an unfair advantage.

HYBRIDS.

Hybridization as a factor in breeding is now widely recognized and used by all careful workers. The object in making hybrids is to secure variations on which to base selection, to combine in one new form the desirable characters found only in two or more parent strains, to secure an accentuation of a character best represented in the two parent types, or sometimes to get a new character not found in either parent or in any of the related forms. The work in hybrid oats, as far as we can tell at present, proves the possibility of successfully carrying out any one of these propositions. The marvelous variations of second generation hybrids gives the widest field for selection. In crossing two varieties to secure a combination of desirable characters, Mendel's theory of germ purity in regard to unit characters has been of great assistance.

In a study of heredity in oat hybrids some interesting things have been noted that have a general bearing on breeding problems. Mendel's theory of heredity certainly applies in part to most of the characters of the oat plant. When the first generation hybrid plants were harvested, their inheritance of parental characters semed to indicate a complete blending but the second year's work showed quite different results. This apparent departure from the germ purity hypothesis was found to be due to the absence of any definite dominance of one character over its alternate. Black and white oats crossed gave a brown hybrid but when the progeny of these brown hybrids were grown, it was found that one-fourth of them were as white as the white parent, one-fourth black, and one-half the hybrid brown again. Since then the black and white extracted types have come pure. Awned and awnless oats crossed gave a partially awned type which next year split up the same way into awned, awnless, and hybrid. Side oats crossed with open headed varieties gave a semi-side oat the first year but followed the same method of segregation in the future.

RED TEXAS HYBRIDS.

Hybrids between *Avena fatua* derivatives and *Avena sterilis* derivatives show many interesting reversions to the wild forms in the

second generation. Type wild awns often appear, also the hairy glumes of the wild parent. In this series of hybrids the appearance of large grained types is one of the most interesting phenomena. Some fixed types are now being grown in our selections that have much larger grains than either parent.

NAKED OAT HYBRIDS.

In the series of naked oats crossed with different hull types, a peculiar correlation was found, which has already been mentioned before this Society by Dr. H. J. Webber. The spikelet of the naked varieties usually has more than three grains while in the hulled types three grains is the limit. The first generation plants produced a head naked at the top and hulled at the bottom. In the second generation, one-fourth of the progeny were typical naked plants, one-fourth were hulled, and one-half like the first generation hybrids. The naked plants all had long spikelets with more than three grains while the hulled plants had spikelets with the usual two or three grains. In future generations no exception to this rule has been found except that one second generation plant of a cross between European Hulles and Garton's Tartar King which seems to have become fixed in the intermediate hybrid type. In this example we have an extremely rare case of the fixation of a heterozygote or hybrid type.

One of the objects of crossing naked with hulled types was to secure a large grained naked oat of high yielding power. Most of this series was discarded early, as they gave no promise. However, a cross between European Hulless and Sixty Day gave among many others one plant which had large grains and in the yield test of last year produced nearly double that of its hulless parent. The grain averages fifty per cent larger than either parent and is equal in size and weight to the hulled grain of our best Illinois varieties. This is a very good example of the possibility of securing a form with a character not found in either parent. It is all the more remarkable since crosses with none of the large grained types gave the desired size.

REPORT OF THE COMMITTEE ON SWINE BREEDING.

By D. A. GAUMNITZ, *Chairman, St. Anthony Park, Minn.*

Breeding swine should mean more than the mere reproduction of species. It should mean the mating and particularly the selection of animals so as to produce individuals which, as breeding animals, would be (1) prolific; (2) regular as breeders; (3) superior as parents, and which as meat producers would be (1) disease resistant, (2) economical converters of plant into animal products; and (3) heavy yielders of dressed carcasses which show profuse muscling and quality of flesh without too small bone.

QUALITIES THAT THE SWINE GROWERS DEMAND IN SWINE.

The swine growers are in search of, and breeders are willing to pay big prices for, swine that will give high-class results. Such results can be secured only by obtaining prepotent animals, possessed of the desirable inherited and transmitting qualities, by providing proper management and conditions for them, and by carefully breeding them. The qualities desired by swine growers and the value placed upon them are wellnigh indeterminable, but it is safe to say that almost universal preference is made in favor of (1) sows that come in season regularly, that rarely if ever do not conceive at first service, and that as a rule, have no trouble at farrowing time, when in proper condition; (2) sows that will raise at least eight pigs at a litter and not give birth to more than twelve on an average; (3) sows that retain the sense of hearing and sight until at least seven years old; that are good mothers, quiet in disposition, excellent milkers, and easy and economical keepers; (4) pigs that resist many diseases of such a nature as inherited weaknesses, common ailments, and infectious diseases that are in some cases proved resistable; (5) pigs that are economical in growth because of a conformation that permits of gains; because of their fitness for pasturing and because of inherited tendencies to produce pounds of gain with minimum feed; (6) pigs that yield heavy percentage in dressing, and that show "quality" in the muscle without an excess of fat or too little bone. Both these features differ somewhat in different localities. A standard of yields when pigs are at a fair degree of fatness might be:

120 lb. pig, 72 per cent.
150 lb. pig, 74 per cent.
200 lb. pig, 76 per cent.
250 lb. pig, 78 per cent.
300 lb. pig, 81 per cent.
350 lb. pig, 83 per cent.
400 lb. pig, 85 per cent.

RECORDS.

Records that will insure selection of animals that will possess certain desirable qualities are necessary. The animal of greatest value is the "occasional" one found among great numbers. To find this one, and those swine of more than ordinary value; and to separate them from the great numbers so that they may be bred among themselves without the admixture of blood from other pigs, necessitates the applying of some "value" measure, after the *best unified conditions of feeding and management* have been provided for the swine. What a few of the "value" measures should be, has already been suggested. What the essential features to be borne in mind in connection with feeding and management are, it is hard to say since local conditions vary so widely and since this science is as yet only imperfectly developed by experiment stations; but some points to be considered are:

1. Methods of feeding.
2. Pastures.
3. Kinds of feeds.
4. Preparation of feeds.

5. Shelter.
6. Breeding.
   .01 Manner and system of mating.
   .02 Ages to breed.
   .03 Time of breeding.
   .04 Miscellaneous.
7. Miscellaneous.

These conditions once settled, the same treatment and chance for growth would prevail.

FOUNDATION STOCK.

In securing the foundation stock a great step might be taken in the right direction by purchasing the stock of hogs that come nearest possessing the "combined values" desired, regardless of show-yard records, if the values assigned are true.

The stock secured, the unified conditions of feeding and management applied, then records must be taken that will be the guide in sorting the desirable from the undesirable animals.

Some breeding-swine records that would be valuable would show:

1. Feeds required per year per hundredweight (for keep).
2. Regularity in conceiving.
3. Prolificacy.
4. Sows as milkers.
5. Sows as to kindness and motherliness.
6. Prepotency.
7. Stamina of litters as regards common ailments.
8. Loss in litters.
9. Size of litters.
10. What pigs amount to at slaughter test (this would probably not be necessary the first year or two).
11. Miscellaneous.

Some litter records that would be helpful in getting an estimate of "value" measures of the litters, are:

1. Average amount of feed required per pig in litter, after weaning, for a given period to make a given weight.
2. Size of litter.
3. Development in general.
4. Development of bone, hair, muscle, and fat, as determined by the slaughter of one or two representatives at a given period from each litter.
5. Disposition as regards intelligence, nervousness.
6. Characteristics in detail.
7. Miscellaneous.

WHO SHOULD TAKE UP BREEDING.

The records necessary to do breeding on a statistical basis are difficult to collect and tabulate. Individual breeders have unconsciously by observation and memory kept these performance records in mind, and a very few of these during their lifetime have succeeded in finding that animal that is peerless among others. Not a few by this same process have been able to build up herds of more than ordinary merit. Had per-

formance records, in both cases, been kept up so that the work might have been continued, and had all the extraordinary animals and this animal that surpasses others been bred together and the poor blood from the low or less than mediocre grade of animals been prevented from creeping in, and the poor animals from the good ones promptly weeded out, no one could say what improvements might reasonably have been expected.

This work may therefore be taken up by a single breeder or on a government farm, but in order to secure great numbers of animals with which to work annually in the hopes of securing this "occasional" valuable animal, and those of more than average in value, in a short time, cooperation among farmers with the state experiment station and the government is strongly advised as the proper and logical course. Not only are these long time projects, if put under government and state supervision with men in charge growing into the work and getting familiar with the records from time to time, going to be immortal, if necessary, but the work will be aided by a better natural scheme for distribution of the good animals produced because their blood will be found in this centralized breeding community. Those men gifted in breeding will have a greater opportunity to do work and to see results secured than in any other plan yet suggested, and there will be extended to the people better systems of keeping breeding records, which in future must mean considerable to breeders. Then, too, where the government aids in disposing of the cost of producing these superior animals, every citizen will help to pay his share in proportion as he is taxed and the government helps. The cooperator will pay in this production by the work he does, the money he invests and the risk he takes. The people in general will be remunerated by getting animal products cheaper because of the better animals produced, and the cooperators, by producing more animals and of greater value than if this extra labor, investment and risk had not been assumed.

THE PLAN.

In carrying out such a plan a cooperative association with about twenty members should be organized in connection with the state experiment station and the Department of Agriculture at Washington. These members should preferably be young men who own and live on their farms and who show a desire or instinct for this sort of work.

The management of this organization should be vested in an executive council of three, composed of one member from the association, one from the experiment station, and one member from the Department of Agriculture, which should supervise, either directly or indirectly as they may deem wise, purchases, breeding, general management, sales and uses of all animals.

The project being a long time one and considerable of the government funds becoming invested, a bond of $200.00 executed in favor of the association should be required of each member and two years'

warning should be required of each member by the council before he can withdraw unless such requirement were waived by the council.

Each member with such public aid as he may be granted should procure a boar, and at least 10 sows, as many as possible possessing performance records such as are desired by the council.

The station and the Department of Agriculture are to assist as far as is feasible in finding, purchasing, and transporting animals at the beginning and during the existence of this association.

The station and the Department of Agriculture, through the council or the council's agent, should collect and tabulate on the per cent basis where possible, all records of whatever nature they may be, every month.

With the aid of such records the council, assisted by their agent, and cooperators, should decide upon a complete scheme for selecting the animals that should be retained and mated, and those that should be sold outside the association.

All the progeny raised by members and retained within the association should be the property of the respective members, subject to such rules of use, distribution, and sale within the association as may be agreed upon by the council and members.

(Signed) COMMITTEE ON BREEDING SWINE.

D. A. GAUMNITZ, St. Anthony Park, Minn., *Chairman.*
N. H. GENTRY, Sedalia, Mo.
WM. DIETRICH, Urbana, Ill.
A. J. LOVEJOY, Roscoe, Ill.
J. G. FULLER, Madison, Wis.
W. H. MCFADDEN, Record Bldg., Chicago, Ill.

DIRECTORY OF MEMBERS.

ANNUAL MEMBERS.

A

Adams, James E., Quincy, Ill., No. 3 Wells Bldg.
Adams, J. F., Hale, Mo., R. F. D., No. 5.
Adams, William, Alice, Texas.
Agricultural College, Logan, Utah, Library.
Agriculture, Department of, Ottawa, Canada.
Agriculture, Department of, Toronto, Canada.
Ainsworth, Harry, Moline, Ill.
Alabama Polytechnic Institute, Auburn, Ala.
Aldrich, Benton, Auburn, Nebr.
Aldrich, Karl, Auburn, Nebr.
Alexander, John T., Chicago, Ill., Exchange Bldg., Union Stock Yards.
Alexander, G. W., Julian, Nebr.
Alexander, L. P., Wheatley, Ky.
Allaire, C. B., San Antonio, N. Mex.
Allen, C. E., Madison, Wis., 810 W. Johnson St.
Allen, C. L., Floral Park, N. Y.
Allen, M. D., Arlington, Colo.
Allen, Paschal, Delavan, Ill.
Ames, Oakes, North Easton, Mass.
Anderson, Alvin M., Whitewater, Wis.
Anderson, A. N., Ong, Nebr.
Anderson, C. H. C., Carlinville, Ill.
Anderson, Leroy, San Luis Obispo, Calif.
Anderson, S. W., Blaker Mills, W. Va.
Anderson, W. B., Velpen, Ind., R. F. D., No. 24.
Andrews, C. W. & W. A., Walhalla, N. Dak.
Andrews, E. L., Bristol, Tenn.
Ankeny, Horace, Xenia, Ohio, R. F. D., No. 7.
Arkell, H. S., Guelph, Canada.
Arnold, A. D., Pawling, N. Y.
Atkinson, Prof. A., Bozeman, Mont.
Aumann, A. C., Arkansas City, Kans., R. F. D., No. 4.
Austin, C. F., Santiago de las Vegas, Cuba.
Atkins, C. B., Milford, Mich.
Axtell-Rush Publishing Co., Pittsburg, Pa.
Ayer, H. D., St. Anthony Park,

B

Babcock, E. B., Los Angeles, Calif., 1443 Burlington Ave.
Bailey, L. H., Ithaca, N. Y.
Bailey, O. J., Peoria, Ill.
Bain, S. M., Knoxville, Tenn.
Baker, E. D., Corvallis, Ore.
Baker, Hugh P., Ames, Iowa.
Baker, Isaac P., Bismarck, N. Dak.
Baker, S. C., San Jose, Calif., Box 810.
Baldwin, F. D., Ipava, Ill.
Ball, Carlton R., Washington, D. C., Department of Agriculture.
Ball, E. D., Logan, Utah, Experiment Station.
Ballachey, G. M., Brantford, Ontario.
Ballou, Geo. Wm., Middletown, N. Y.
Balz, Sylvester, Highmore, S. Dak.
Barre, Henry W., Lincoln, Nebr., Station A.
Barnes, Geo. W., Norwalk, Ohio, 232 W. Main St.
Barnes, W. A., Marston, Mo.
Bassett, L. B., St. Anthony Park, Minn.
Bassett, Frank, Tippett, Nev.
Bates, A. A., Irwin, Ohio.
Beach, F. H., Morristown, N. J.
Beach, Prof. S. A., Ames, Iowa.
Beal, W. J., Agricultural College, Mich.
Bealey, J. N., Morrill, Kans., R. R. No. 2.
Beall, A. J., Davistown, Pa.
Beard, Chas. E., Milford, Utah.
Beattie, Prof. R. Kent, Pullman, Wash., Expt. Station.
Beatty, F. E., Three Rivers, Mich.
Bebout, J. C., Canonsburg, Pa.
Becker, G. H., Victoria, Ill.
Bell, F. C., Mt. Vernon, Ohio.
Bell, Jas. C., Bozeman, Mont.
Bennett, Frank P., Boston, Mass., 530 Atlantic Ave.

Benton, Frank, Washington, D. C., Bureau of Entomology.
Berry, J. B., St. Paul, Minn., 995 Linwood Place.
Bessey, Dr. Chas. E., Lincoln, Nebr., Univ. of Nebr.
Bessey, Ernst A., Miami, Fla.
Beuchler, J. R., Leesburg, Va.
Bierman, H. A., Farmer's Voice, Chicago, Ill.
Bigham's Sons, Wm. M., Gettysburg, Pa.
Bines, R. S., Ridgfarm, Ill.
Bioletti, F. F., Berkeley, Calif.
Birch, Raymond B., Manila, Philippine Islands, Bureau of Agriculture.
Bishopp, B. G. D., Denver, Colo.
Bissell, E. N., East Shoreham, Vt.
Black, W. G., Winnipeg, Manitoba, Agricultural College.
Blacow, C. R., Paauilo, Hawaii.
Blake, Chas. S., Ashby, Mass.
Blinn, Philo. K., Rocky Ford, Colo.
Bliss, Dean S., Burlington, Vt., R. F. D., No. 1.
Bolch, C. P., Durfur, Ore.
Bolley, H. L., Fargo, N. Dak., Agricultural College.
Bolte, J. Willard, Kingston, R. I.
Boocock, Murray, Keswick, Va.
Booth, Edwin G., Stanley, N. Y.
Boothroyd, P. H., Loveland, Colo.
Boss, Andrew, St. Anthony Park, Minn.
Boucsein, Gust, Detroit Harbor, Wis.
Boyd, Mossom M., Bobcaygeon, Ontario.
Bowman, M. L., Ames, Iowa.
Brand, Horace H., Plattsburg, N. Y., R. F. D., No. 6.
Brenizer, J. G., Broken Bow, Nebr.
Bridgeforth, G. R., Tuskegee Inst., Ala.
Bridgford, C. W., Joy, Ill.
Brierly, W. G., Farm School, Pa.
Brigham, Arthur A., Marlboro, Mass.
Broce, I. H., Blacksburg, Va.
Brock, A. M., Greub, Wyo.
Brooks, I. S., Urbana, Ill.
Brooks, Wm. P., Amherst, Mass.
Brown, E. B., Washington, D. C., Bureau of Plant Industry.
Brown, Eugene D., Scottsville, N. Y.
Brown, Dr. H. M., Hillsboro, Ohio.
Brown, J. H., Iola, Kans.
Brown, J. Stanford, Yonkers, N. Y.
Brown, L. C., La Grange, Ill.
Brown, H. F., Minneapolis, Minn.
Brown, R. J., Morning Sun, Ohio.
Bryant, R. E., Pullman, Wash.
Buchanan, J., Guelph, Ontario.
Buffum, B. C., Laramie, Wyo.
Bugby, M. O., Wooster, Ohio, Expt. Station.
Bundley, T. H., Hinsdale, Ill., Natoma Farm.
Burghardt, W. A., Mohler, Idaho.
Burkett, Prof. C. W., Manhattan, Kans.
Burleson ,W. L., Stillwater, Okla.
Burnett, E. A., Lincoln, Nebr.
Burnette, F. H., Newark, N. Y.
Burnette, L. C., Ames, Iowa.
Burr, W. W., Lincoln, Nebr., Station A.
Burrill, T. J., Urbana, Ill.
Burrows, J. B., Decatur, Ill.
Burton, W. F., Afton, Wyo.

C

Cady, LeRoy, St. Anthony Park, Minn.
Caine, John T., Logan, Utah.
Caine, Thos. A., Hammond, La.
Caldwell, W. H., Peterboro, N. H.
Campbell, P. A., Orono, Maine.
Canterbury, C. E., Cantrall, Ill.
Card, Prof. Fred. W., Kingston, R. I.
Cardoza, F. H., Tuskegee, Ala.
Carleton, M. A., Bureau of Plant Industry, U. S. D. A.
Carlyle, Alex., St. Anthony Park, Minn.
Carlyle, Dean W. L., Ft. Collins, Colo.
Carmichael, B. E., Wooster, Ohio.
Carmichael, James, Rochelle, Ill., R. F. D., No. 1.
Carpenter, Director L. G., Ft. Collins, Colo.
Carver, Geo. W., Tuskegee, Ala.
Cary, C. A., Auburn, Ala.
Cary, Walter E., Hayden, Colo.
Cary & Son, Wm. W., Lyonsville, Mass.
Castle, W. E., Cambridge, Mass.
Cauthen, E. F., Wetumpka, Ala.
Chakravarty, J. N., care of G. N. Lauman, Ithaca, N. Y., College of Agriculture.
Chamberlain, W. I., Hudson, Ohio.
Chapman, Ronald E., Pullman, Wash., Expt. Station.
Chatfield, E. C., Minneapolis, Minn.
Chenoweth, Jesse A., Greenville, Ohio, R. F. D., No. 9, Box 87.
Chester, D. H., New York, N. Y., 95 Liberty St.
Chester, E. E., Champaign, Ill.

Chester, T. P., Champaign, Ill.
Childs, S. P., Shakopee, Minn.
Christianson, P. A., Hinckley, Minn.
Clark, Frank W., Princeton, Ill.
Clark, Geo. H., Ottawa, Canada, Dept. of Agriculture.
Clark, J. D., Whitewater, Wis.
Clark, Rev. John Y., Fromberg, Mont.
Clark, Prof. V. A., Phoenix, Ariz.
Claxton, R. I., Fayette, Iowa.
Cleaver, Edw. W., Meadowbrook, N. Y.
Cleveland, Chas. C., Creighton, Nebr.
Clinton, Director L. A., Storrs, Conn.
Clisby, J. R., Arcola, Ill.
Clos, William C., Washington, D. C., Forest Service.
Close, C. P., College Park, Md.
Clothier, Geo L., Agricultural College, Miss.
Cobb, Prof. N. A., Department of Agriculture, Washington, D. C.
Coburn, J. L., Logan, Utah.
Coffee, W. C., Urbana, Ill., Univ. Station.
Coit, J. Eliot, Tucson, Ariz., care of Experiment Station.
Cole, John S., Brookings, S. Dak.
Cole, Leon J., Kingston, R. I.
Comings, Geo. H., St. Anthony Park, Minn.
Consterdine, E., Hammond, La.
Cook, Isaac S., Jr., Chillicothe, Ohio, R. R. No. 1.
Cook, J. H. M., Essex Falls, N. J.
Cook, O. E., Odebolt, Iowa.
Cooney, B. W. Ogallala, Nebr
Cort, E. G., Huron, S. Dak.
Cote, J. C., Ottawa, Canada, Office of Seed Commissioners.
Cotton, J. S., Bureau of Plant Industry, U. S. D. A.
Cox, Simon, Wyoming, Ill.
Craig, A. G., Pullman, Wash.
Craig, Prof. John, College Station, Texas.
Crandall, C. S., Urbana, Ill., Univ. of Ill.
Crandall, L. V., Red Wing, Minn.
Crandall & Danforth, Randolph, Minn.
Crawford, M., Shiocton, Wis.
Crerar Library, John, Chicago, Ill.
Cross, A. B., Racine, Ohio.
Cross, Wm., Childs, Minn.
Crosthwait, G. A., Urbana, Ill., 506 S. Mathews Ave.
Cuba, Frank M.
Cummings, M. B., Orono, Maine, Univ. of Maine.
Cunningham, C. C., Manhattan, Kans.
Currie Bros. Co., Milwaukee, Wis.

D

Dakota Farmer, Aberdeen, S. Dak.
Dalrymple, W. H., Baton Rouge, La.
Darlington, Philip S., Moscow, Idaho.
Datta, Divijadas, Ithaca, N. Y., care of Prof. G. N. Lauman.
Davenport, E., Urbana, Ill.
Davis, A. W., St. Louis, Mo., 2912 Pine St.
Davis, H. W., Jr., Sussex, Wyo.
Davis, Vernon H., Columbus, Ohio, Univ. of Ohio.
Davis, W. J., Jr., Youngsville, Pa.
Davies, Robert, Toronto, Canada, 36 Toronto St.
Davison, Charles S., New York, N. Y., 60 Wall St.
Davison, G. Howard, Millbrook, N. Y.
Dawley, F. E., Fayetteville, N. Y.
Dawson, James A., Heber City, Utah.
Day, Prof. G. E., Guelph, Ontario, Canada.
Dean, James T., Ottosen, Iowa.
De Cew, Thos. H., Chicago, Ill., 167 Dearborn St.
Delmard, Alaricus, Hotel Santa Brigida, Grand Canary.
Denny, F. E., Lincoln, Nebr., Agrl. Expt. Station.
Derr, H. B., Washington, D. C., 103 Seaton Place, N. W.
Devol, Jas. S., Marietta, Ohio.
De Vries, Prof. Hugo, Amsterdam, Holland.
Dexter, Wm. Hart, Columbus, Ohio.
Dickey, Dr. T. A., Middletown, Ohio.
Dietrich, Wm., Urbana, Ill.
Dillman, Arthur C., Brookings, S. Dak.
Dimock, Dr. W. W., Merrow, Conn.
Dodson, W. R., Baton Rouge, La.
Doehling, G. C., Surprise, Nebr.
Dondlinger, P. F., 242 W. 46th St., New York, N. Y.
Dorner, Fred., Lafayette, Ind.
Dorrance, Anne, Dorranceton, Pa.
Doubt, Wm. A., Havelock, Nebr.
Douglas, J. S., Bakersfield, Calif., San Emigdo Ranch.
Douglas, William, Dow, Mich.
Drew, James M., St. Anthony Park, Minn.
Drinkhard, A. W., Jr., Blacksburg, Va.

DuBois, Ernest B., San Rafael, Calif.
Duerden, J. E., Grahamstown, South Africa, Rhodes University College.
Duggar, J. F., Auburn, Ala.
Duluth Co., Jean, Duluth, Minn.
Dungan, W. O., Minden, Nebr.
Dunlap, John H., Williamsport, Ohio.
Dunmire, Geo. M., Scotland, S. Dak.
Dutt, H. L., care of G. N. Lauman, Ithaca, N. Y., Cornell University.

E

East, Prof. E. M., New Haven, Conn., Expt. Station.
Eatman, O. R., Mantua, Ala.
Ebert, Francis E., Tomah, Wis.
Eckhardt, Wm. G., Urbana, Ill.
Eden Hill Farm, Stockbridge, Mass.
Eder, Theo., Perkins, Calif.
Edwards, W. C., Ltd., Rockland, Ontario, Canada.
Eidmann, G. H., Mascoutah, Ill.
Elliott, E. E., Pullman, Wash.
Ellis, R. N., Newport, R. I.
Elling, Carl G., Santiago de las Vegas, Estacion Central Agronomique, Cuba.
Elling, O. H., Hays, Kans.
Elliott, Prof. W. J., Bozeman, Mont.
Ellwanger & Barry, Rochester, N. Y.
Ely, L. D., Rochester, N. Y.
English, W. L., Stillwater, Okla.
Erbach, Wm. L., Athens, Wis.
Esler, John G., Saddle River, N. J.
Estrees d', J., care of Alaricus Delmard, Hotel Santa Brigida, Monte, Grand Canary.
Ewing, C. E., Agricultural College, Miss.
Ewing, Rev. Chas. E., Shrewsbury, Mo.

F

Fairchild, D. G., Washington, D. C.
Farnum, H. C., Bessemer, Ontario.
Favor, E. H., Columbia, Mo.
Ferguson, A. M., Sherman, Texas.
Ferguson, J. J., Chicago, Ill., care of Swift & Co.
Ferneybaugh, Dr. J. G., Blacksburg, Va.
Ferry, T. R., Pleasant Plains, Ill.
Finney, E. E., Marengo, Ohio, R. F. D., No. 4.
Finsnes, Andrew, Stoughton, Wis.
Flagg, Chas. O., Hardwick, Mass.
Fletcher, H. E., Minneapolis, Minn., 512 Andrus Bldg.
Florists' Exchange, New York, N. Y., Box 1697.
Flowers, Montaville, Cincinnati, Ohio, 7th & Elm Sts.
Flumm, Thomas, Morgantown, W. Va., R. R. No. 5.
Fogle, P. E., Beaver Creek, N. C.
Foord, J. A., Columbus, Ohio, O. S. U.
Forbes, E. B., Columbia, Mo.
Forbes, W. A., Pittsfield, Mass., Blythewood Farm.
Ford & Graham, Washington, D. C., 609 15th St., N. W.
Fowler, Clarence, Durham, N. H.
Frank, J. H., Anoka, Minn.
Fraser, Samuel, Geneseo, N. Y., Box 215.
Freeman, Geo. F., Manhattan, Kans.
French, W. L., Peru, Nebr.
Frost, Howard B., Dairyland, N. Y., Ulster Co.
Fruit Grower, St. Joseph, Mo.
Fuller, Jas. G., Madison, Wis.
Funk, Lyle W., Bloomington, Ill.

G

Gain, J. H., Lincoln, Nebr.
Galloway, B. T., Washington, D. C., Dept. of Agriculture.
Gammon, B. O., Des Moines, Iowa.
Gammon, E. W., St. Charles, Iowa.
Gammon, Warren, Des Moines, Iowa.
Gardner, E. T., Trenton, Nebr.
Garcia, Fabian, Agricultural College, N. Mex.
Garver, E. R., Ames, Iowa, Box 101, Route 3.
Garwood Bros., Stonington, Ill.
Gaumnitz, A. J., Berkeley, Calif., 1626 Oxford St.
Gaumnitz, D. A., St. Anthony Park, Minn.
Gay, Prof. C. W., Ithaca, N. Y.
Geary, Clinton, Polo, Ill.
Geismar, Leo. M., Chatham, Mich.
Gentry, N. H., Sedalia, Mo.
George, William, Aurora, Ill.
Georgeson, C. C., Sitka, Alaska.
Gerlaugh, J. A., Harshman, Ohio, R. F. D., No. 1.
Gernert, W. B., McPherson, Kans.
Ghosh, A. C., Ithaca, N. Y., 140 Huestis St.
Gilbert, A. W., Orono, Maine, Univ. of Maine.
Gill, John W., Columbus, Ohio.

Gillette, C. P., Ft. Collins, Colo.
Gillis, R. H., Mt. Pleasant, Iowa.
Gilmore, John W., State College, Pa.
Gilkerson, Hiram, Genoa, Ill., R. R. No. 3.
Girault, A. A., Washington, D. C., Dept. of Agriculture.
Girardet, J. J., Denver, Colo., Dairy Commissioner's Office.
Glover A. J., Ft. Atkinson, Wis.
Goddard, L. H., Wooster, Ohio.
Good, E. S., Lexington, Ky., Expt. Station.
Goode, Solon L., Indianapolis, Ind.
Gowell, G. M., Orono, Maine.
Grace, Oliver, Dickinson, N. Dak.
Green, J. E., Hartford City, Ind.
Green, Joseph H., Gregory, Texas.
Greene, John P., Albert Lea, Minn.
Green, S. B., St. Anthony Park, Minn.
Green, Stephen N., Medina, Ohio.
Greene, Wesley, Des Moines, Iowa.
Greenleaf, M., Alexander, Ill.
Griffiths, W. G., McNabb, Ill.
Grindley, H. S., Urbana, Ill.
Groff, H. H., Simcoe, Ontario, Canada.
Groves, J I., Champaign, Ill.
Gude, J. H., Washington, D. C., 910 H St., N. W.
Guernsey Breeders' Assn., Avondale, Pa.
Guernsey Breeders' Assn., Rosendale, Wis.
Guthrie, W. W., Atchison, Kans.
Guthrie, E. S., Columbus, Ohio, O. S. U.

H

Haecker, A. L., Lincoln, Nebr., Station A.
Haight, Jr., S. J., Earlville, Ill.
Hale, Philip H., St. Louis, Mo.
Hall, D. S., Buffalo Lake, Minn.
Hall, H. F., Durham, N. H.
Hall, L. D., Urbana, Ill., Univ. of Ill.
Halstead, E. W., Santiago de las Vegas, Estacion Central Agronomique, Cuba.
Hamilton, W. A., Lake Bluff, Ill.
Hamilton, W. A., Hoopeston, Ill.
Hansen, Prof. N. E., Brookings, S. Dak.
Hansen, W. S., Collinston, Utah.
Hardie, Wm., Birmingham, Ala.
Harper, Prof. R. A., Madison, Wis., Univ. of Wis.
Harris, N. J., Des Moines, Iowa, Box 507.
Harris, Roy T., Madison, Wis., Expt. Station.
Harrison, C. S., York, Nebr.
Hart, J. Wm., Pirscicaba, Brazil, S. A.
Harter, L. L., Washington, D. C., Dept. of Agriculture.
Hartley, C. P., Washington, D. C., Bureau of Plant Industry.
Hartwell, Chas. A., American Sugar Co., Honolulu, Hawaii.
Hasenwinkle, Henry, Bloomington, Ill.
Haskell, Sidney B., Southbridge, Mass.
Hastings, F. S., Stamford, Texas.
Hauser, True, Wooster, Ohio, Expt. Station.
Headley, F. B., San Antonio, Texas.
Heald, F. D., Lincoln, Nebr., Expt. Station.
Heikes, W. F., Huntsville, Ala.
Henderson, P. G., Central City, Iowa.
Hewitt, James H., Gouverneur, N. Y.
Higgins, J. E., Honolulu, Hawaii, Box 667.
Hildreth, C. E., Altamont, Kans.
Hill, Jas. J., St. Paul, Minn.
Hill, Myron W., Leechburg, Pa.
Hills, V. T., Delaware, Ohio.
Hine, Jerome P., Shinrock, Ohio.
Hinz, A. F., Ripon, Wis.
Hockersmith, L. A., Benton, Ark.
Hoge, Jos. M., Washington, D. C., 915 La. Ave.
Holden, P. G., Ames, Iowa.
Holt, Sidney V., Oneida, Ill.
Holtermann, R. F., Brantford, Ontario, Canada.
Hoopengardner, F. P., Ossian, Ind.
Hope, J. L., Madison, N. J.
Hopkins, A. D., Bureau of Entomology, U. S. D. A., Washington, D. C.
Hopper, Herbert A., Urbana, Ill.
Hopt, Erwin, Lincoln, Nebr
Horne, Prof. W. F., Santiago de las Vegas, Estacion Central Agronomique, Cuba.
Hottes, Chas. F., Urbana, Ill.
Howard, Edw. W., San Mateo, Calif.
Howe, Geo. B., Black River, N. Y.
Hoy, Peter, Lombard, Ill.
Hubbard, Holsy S., Madeira, Ohio.
Humbert, E. P., Ames, Iowa, Agricultural College.
Hume, A. N., Urbana, Ill.
Hummer, Geo. A., Prairie Point, Wis., R. F. D. No. 1.
Humphrey, G. C., Madison, Wis.

Hunt, Rex, Pullman, Wash., Expt. Station.
Hunt, Dean Thomas F., State College, Pa.
Hurd, Prof. Wm. D., Orono, Maine.
Hurst, Chas. C., Burbage, Leicestershire, England.
Hurst, Ralph, Dayton, Wash., R. F. D., No. 3, Box 23.
Hutt, W. N., Raleigh, N. C., Dept. of Agriculture.

I

Iddings, Edw. J., Ft. Collins, Colo., 202 W. Laurel St.
Ingalls, Harry E., Sugar City, Colo.
Ingram, I. S., Marvyn, Ala.
Iorms, Martin J., Mayaguez, Porto Rico.
Irvine, Thomas, St. Paul, Minn., 677 Dayton Ave.
Irwin, W. N., Washington, D. C., Dept. of Agriculture.

J

Jardine, W. M., Washington, D. C., Dept. of Agriculture.
Jarvis, C. D., Storrs, Conn., Expt. Station.
Jarvis, H. K., Champaign, Ill.
Jenkins, E. H., New Haven, Conn., Expt. Station.
Jenkins, J. M., Wetumpka, Ala.
Jennings, H., Southold, N. Y.
Jensen, C. N., Ephraim, Utah.
Jewell Nursery Co., Lake City, Minn.
Johannesohn, S., Beltrami, Minn.
Johnson, Benjamin, Richmond, Ind.
Johnson, Chas. G., Clintonville, Wis., R. F. D. No. 1.
Johnson, Dr. F. E., Lincoln, Nebr., Box 521.
Johnson, Roswell H., Cold Spring Harbor, Long Island, N. Y.
Johnston, R. C., Lawrence, Kans.
Jones, E. R., Rosser, Manitoba.
Jones, J. F., Jeanerette, La.
Jones, J. W., Ames, Iowa.
Jordan, President David Starr, Leland Stanford Univ., Calif.
Judson, Prof. L. B., Ithaca, N. Y.

K

Kampe, F. H. C., East Alstead, N. H.
Kearney, T. H., Washington, D. C., Department of Agriculture.
Keene, F. A., Jr., Valencia, Kans.
Keeney, C. N., Le Roy, N. Y.
Keffer, Charles A., Knoxville, Tenn.
Kellogg, Geo. J., Lakemills, Wis.
Kellogg, Prof. V. L., Leland Stanford Univ., Calif.
Kendall, F. A., Sioux Falls, S. Dak.
Kern, Frank F., Lafayette, Ind.
Keyser, Alvin, Lincoln, Nebr.
Keyser, Val, Lincoln, Nebr.
Keystone Veterinary Medical Assn., Philadelphia, Pa.
Kidder, A. F., Urbana, Ill.
Kilgore, B. W., Raleigh, N. C.
Kincaid, J. E., Athens, Ill.
Kinman, C. F., Ithaca, N. Y.
Kinslar, John H., Victoria, Texas.
Kirkpatrick, E. A., McKinney, Texas, 49 Parker St.
Klinck, L. S., St. Anne de Bellevue, Quebec.
Knorr, F., Ft. Collins, Colo.
Knorr, Geo. W., Clark, Ky., Jefferson Co.
Knott, Elmer, Fisher, Ill.
Krauss, F. G., Honolulu, Hawaii, Expt. Station.
Kristjanson, Th. T., Gardar, N. Dak.
Krum, Harry G., White Bear, Minn.
Kyle, C. H., Wooster, Ohio.

L

Ladage, Fred. W., Auburn, Ill., R. F. D., No. 45.
Laferriere, Wm. J., Brantford, Calif.
Lambert, Clarence, Hiawatha, Kans.
Langelier, Gus., Cap Rouge, Quebec.
Langlais, E. C., Ames, Iowa.
Larrabee, C. X., S. Bellingham, Wash.
Larsen, C., Logan, Utah, Agricultural College.
Lauman, G. N., Ithaca, N. Y., Cornell Univ.
Lawrence, Claude W., Pullman, Wash.
Lawrence, George, Pullman, Wash.
Lawrence, Wm. H., Pullman, Wash.
Lazenby, W. R., Columbus, Ohio, O. S. U.
Le Duc, Wm. G., Hastings, Minn.
Lee, E. W., Granton, Wis.
Lee, Henry T., Fingal, N. Dak.
Lee, Ross F., Bedford, Pa.
Lee, Prof. Thomas G., Minneapolis, Minn.
Lefevre, George, Columbia, Mo., Univ. of Mo.
Lehrenkraus, Alfred, Hohenheim, Germany.
Leib, S. F., San Jose, Calif.

Leidigh, A. H., Amarillo, Texas.
Levering, Mortimer, Lafayette, Ind.
Lewis Bros., Marshalltown, Iowa.
Lillie, Frank R., Chicago, Ill., Univ. of Chicago.
Linfield, Director F. B., Bozeman, Mont.
Lingo, L. L., Quaker City, Ohio.
Linnell, C. W., Center City, Minn.
Lloyd, R. C., Sibley, Ill.
Lloyd, E. R., Agricultural College, Miss.
Lloyd, John W., Champaign, Ill., 1005 S. Wright St.
Linklater, W. A., Pullman, Wash.
Loewe, Arthur, Shiocton, Wis.
Longley, H. N., Dousman, Wis.
Loseke, Edw. G., Columbus, Nebr.
Love, H. H., Urbana, Ill.
Lutz, Frank E., Cold Spring Harbor, N. Y.
Lyon, Prof. Harold L., Minneapolis, Minn., Univ. of Minn.
Lyon, T. L., Ithaca, N. Y.

M

McCain, Robert B., Oswego, Ill., R. F. D., No. 1.
McCall, Prof. A. G., Columbus, Ohio, O. S. U.
McCarty, John, Arcola, Ill., Route No. 5.
McCaulay, R., Westmont, Montreal, Canada.
McClelland, Geo., St. Paul, Minn., Agricultural College.
McClendron, S. E., Baton Rouge, La.
McCollom, Jas. P., Ferris, Ill., R. F. D. No. 1.
McCracken, J., Stanford University, Calif.
McDowell, R. H., Reno, Nev., Box 797.
McFayden, H., Regina, Canada.
McGalliard, Thos. A., Garza, Texas.
McGuire, A. J., Grand Rapids, Minn.
McKelvie, S. R., Lincoln, Nebr.
McKerrow, Geo., Pewaukee, Wis.
McKinney, J. G., Wilsonville, Nebr.
McLaughlin Bros., St. Paul, Minn.
McLean, D. J., Cokato, Minn.
McLean, J. A., Ames, Iowa, Station A.
McMillan, H. G., Cedar Rapids, Iowa.
McNown, I. A., Moline, Kans.
MacDougal, Dr. D. T., Tucson, Ariz., Desert Botanical Laboratory.
Mace, A. G., Lexington, Ind.
Mackintosh, R. S., Auburn, Ala.
Macoun, W. T., Ottawa, Canada, Expt. Station.
Maiben, A. R., Palmyra, Nebr.
Maiben, Ben., Palmyra, Nebr.
Major, C. W., Berkeley, Calif.
Mann, F. I., Gilman, Ill.
Mann, Wm. I., Trumansburg, N. Y.
Marble, John E., Los Angeles, Calif., H. W. Hillman Bldg.
Mark, Prof. E. L., Cambridge, Mass., 109 Irving St.
Markham, Francis G., Dorranceton, Pa.
Marquis, J. Clyde, Springfield, Mass., 68 Pearl St.
Marshall, C. J., Philadelphia, Pa., 2004 Pine St.
Marshall, F. R., College Station, Texas.
Marshall, Samuel H., Charlottesville, Va.
Martin, Leslie, Lebanon, Tenn.
Marty, Mentor, Courtland, Kans.
Massey, W. F., Philadelphia, Pa., Practical Farmer.
Mata, G., Jr., Ames, Iowa.
Mathews, Prof. Clarence W., Lexington, Ky., 660 S. Limestone St.
Maxcy, Leigh F., Curran, Ill.
Mayo, N. S., Santiago de las Vegas, Cuba, Estacion Central Agronomique.
Melick, C. B., San Angelo, Texas.
Melick, Chas. W., College Park, Md.
Meliss, D. E., San Francisco, Calif.
Metcalfe, C. B., San Angelo, Texas.
Meyer, A. J., Webberville, Mich.
Michigan Farmer, Detroit, Mich.
Michigan, University of, Ann Arbor, Mich.
Miller, M. F., Columbia, Mo.
Millisack, Roy S., Oskaloosa, Iowa.
Mills, Chas. F., Springfield, Ill., 510 E. Monroe St.
Minn. Live Stock Breeders' Assn., St. Anthony Park, Minn.
Mining Review & Metallurgist, Chicago, Ill., 356 Dearborn St.
Mitra, Hari Prosad, Ithaca, N. Y., care of Prof. G. N. Lauman.
Moenkhaus, W. J., Bloomington, Ind.
Moncrief, Joseph, Winfield, Kans.
Monnich, Geo., Hooper, Nebr.
Monson, Jacob, Winona, Idaho.
Montgomery, E. G., Lincoln, Nebr.
Mooney, John A., Valley River, Manitoba.
Moore, Frederick Wm., Bedford, England, 13 Goldington Road.
Moore, J. P., Morgan, Ky.

Moore, K. C., Cairo, Ga.
Moore, R. A., Madison, Wis.
Morehouse, L. A., Stillwater, Okla.
Morris, Sir Daniel, Barbadoes, West Indies.
Morrow, Wm., Conrad, Iowa.
Morton, Geo. E., Laramie, Wyo.
Mosbaek, Ludwig, Onarga, Ill.
Mott, E. E., Glenwood, Mich.
Muir, Harry S., Winnebago, Minn.
Mumford, Prof. Herbert W., Urbana, Ill.
Munro, Wm. A., Morrisburg, Ontario.
Munson, F. V., Denison, Texas.
Munson, W. M., Orono, Maine.
Murray, James, Regina, Canada.
Muth Co., Fred. W., Cincinnati, Ohio.
Myers, J. E., Wagram, Ohio.
Myers, M. E., Broken Bow, Nebr.

N

Nachtrieb, Prof. H. F., Minneapolis, Minn., Univ. of Minnesota.
Nandain, Wm. P., Marshalltown, Del., R. F. D. No. 1.
Nash, C. W., College Park, Md.
Nash, J. T. R., Minden, Nebr.
Neale, A. T., Newark, Del.
Nelson, J. B., Bozeman, Mont.
Nelson, J. C., Champaign, Ill.
Nelson, O. M., Stromsburg, Nebr.
Nelson, Dr. S. B., Pullman, Wash., Expt. Station.
Newman, C. L., Clemson College, S. C.
Newman, L. H., Ottawa, Canada, Canadian Bldg.
Nicholas, R. E., Bitterne Park, Hants, England.
Nicholson, John F., Stillwater, Okla.
Nickey, P. A., Kearney, Nebr.
Nixon, Charles D., Owego, N. Y.
Norrish, Miss G. A., Hastings, Minn.
Northrop, Prof. Robert S., Logan, Utah.
North-West Farmer, Winnipeg, Manitoba.
Norton, J. B., Ithaca, N. Y.
Norton, J. B. S., College Park, Md.
Novik, P. M., College Park, Md.
Nye, Wm. F., Burlington, Vt., Expt. Station.

O

Obrecht, Prof. R. C., Urbana, Ill.
Odell, Frank G., College View, Nebr.
Off, Chas. D., Warrensburg, Ill.
Olin, W. H., Ft. Collins, Colo., 829 Peterson St.
Ollis, J. A., Jr., Ord, Nebr.
Oppliger, E. J., Hancock, Minn.
Osborne, Prof. Herbert, Columbus, Ohio.
Ostermeier, John, Cornland, Ill.
Otis, D. H., Madison, Wis.
Overton, J. M., Nashville, Tenn.
Owens, H. L., Burlington, Iowa, 409 Summer St.

P

Pace, E. S., Oxford, Ala.
Pacific Homestead, Salem, Ore.
Paddock, W., Fort Collins, Colo.
Palm, F. C., Mellott, Ind.
Palmer, Dr. T. S., Biological Survey, Dept. of Agriculture, Washington, D. C.
Palmer, Will H., Columbus, Ohio, Townshend Hall.
Pammel, Prof. L. H., Ames, Iowa.
Parker, E. C., St. Anthony Park, Minn.
Parker, H. M., James Island, S. C.
Partridge, H. E., Minneapolis, Minn.
Paterson, T. G., Fergus Falls, Minn.
Patten, Chas. G., Charles City, Iowa.
Patterson, H. J., College Park, Md.
Paull, Leslie F., Ft. Collins, Colo.
Payne, J. E., Garden City, Kans.
Pearson, Dr. Leonard, Philadelphia, Pa., 36th, & Woodland Ave.
Pearson, R. A., Ithaca, N. Y.
Pelham, J. L., Manhattan, Kans., Agricultural College.
Pendar, Oliver S., Sioux Falls, S. Dak.
Penna. State College, State College, Pa.
Perkins, W. R., Agricultural College, Miss.
Peters, E. S., Calvert, Texas.
Peterson, E. G., Logan, Utah.
Peterson, W. A., Yuma, Ariz.
Pettitt, J. H., Urbana, Ill.
Petzke, Ernest A., Hixton, Wis.
Pfaender, Wm., Jr., New Ulm, Minn.
Pfeffer, Wm., Cupertino, Calif.
Phillips, J. L., Blacksburg, Va.
Pickering, A. L., Wagram, Ohio.
Pickett, B. S., Urbana, Ill., College of Agriculture.
Pinney, Wm. E., Valparaiso, Ind.
Pittman, E. D., Mahomet, Ill.
Pollard, Isaac, Nehawka, Nebr.
Pomeroy, C. S., Burlington, Vt., 147 Loomis St.
Pomeroy, J. C., Burlington, Vt., 135 Loomis St.

Poston, R. H., Duluth, Minn., Duluth Stock Farm.
Potter, Geo. P., Peabody, Kans.
Powell, Geo. T., Ghent, N. Y.
Power, Chas. P., Cantrall, Ill.
Power, F. W., Salem, Ore.
Presley, Hiram J., Port Huron, Mich., 2360 10th St.
Price, Prof. H. L., Blacksburg, Va.
Price, L. C., Lexington, Ky.
Price, W. J., Blacksburg, Va.
Pugsley, C. W., Woodbine, Iowa.
Putnam, C. E., Cowles, Nebr.

Q

Quicksall, J. L., Waco, Texas.
Quinn, C. E., Washington, D. C., Department of Agriculture.

R

Rambo, J. R., Collingdale, Pa.
Ramirez, Juan M., Agricultural College, N. Mex.
Ramsey, F. F., Austin, Texas.
Randall, E. W., Hamline, Minn.
Randall, Frank L., St. Cloud, Minn., Supt. State Reformatory.
Rankin, Fred. H., Urbana, Ill.
Rauchfuss Bros., Denver, Colo., 1440 Market St.
Raut, Alfred, Hoopeston, Ill.
Readey, J. C., Tisdale, Saskatchewan, Canada.
Readhimer, J. E., Urbana, Ill.
Reasoner, J. R., Urbana, Ill.
Reaugh, Harry W., Pullman, Wash.
Redfield, C. L., Chicago, Ill., 1503 Monadnock Bldg.
Reeve, H. W., Choctaw, Okla.
Rehl, Wm. J., Zanesville, Ohio.
Reporter Pub. Co., Nat'l Stock Yards, Ill.
Reynolds, C. P., Chicago, Ill., Prairie Farmer.
Reynolds, Edw. E., Lafayette, Ind., R. F. D., No. 7.
Rhode Island Expt. Station, Kingston, R. I.
Rice, B. B., Grand Island, Nebr.
Rice, Edward L., Delaware, Ohio.
Rice, Prof. James E., Ithaca, N. Y.
Rice Journal & Southern Farmer, Crowley, La.
Richards, W. B., Agricultural College, N. Dak.
Riegel, Mark, Pomona, Ga.
Riley, E. H., Bethesda, Md., Expt. Station.
Ring, M. C., Neillsville, Wis.
Robbins, E. T., Ames, Iowa.
Roberts, H. F., Manhattan, Kans.
Robertson, Prof. Wm., Crookston, Minn.
Robeson, F. K., Champaign, Ill.
Robinson, T. P., Bartlett, Texas.
Rockhill, H., Conrad, Iowa.
Roeding, Geo. C., Fresno, Calif.
Rolfs, P. H., Lake City, Fla.
Root Co., A. I., Medina, Ohio, care of C. L. Borden.
Roudebush, Lowell, New Richmond, Ohio.
Rowe & Son, W. H., Jacksonville, Ill., R. F. D., No. 7.
Ruth, Gus. W., Summerfield, Ill.
Rutherford, Dr. J. G., Live Stock Commissioner, Ottawa, Canada.
Rutherford, W. J., Winnipeg, Canada.
Ryan, Geo. A., Indianapolis, Ind., care of Western Horseman.

S

Salaverria, E., Ames, Iowa.
Salmon, Cecil, Brookings, S. Dak.
Sampson, A. W., Lincoln, Nebr.
Sanders, Geo. E., Ontario Agricul-
Sandsten, Prof. E. P., Madison, Wis. tural College, Guelph, Ontario, Canada.
Saunders, Chas. E., Ottawa, Canada, Expt. Station.
Saunders, Dr. Wm., Ottawa, Canada, Expt. Station.
Schaefer, Marx, Yazoo City, Miss.
Schelling, A., Burbank, Calif., P. O. Box 101.
Schindler, Dietrich, Nebraska City, Nebr.
Schroeder, Chris., Madison, Wis., 1530 University Ave.
Schroeder, E. C., Bethesda, Md., Bureau of Animal Industry.
Scott, John M., Gainesville, Fla.
Scott, J. W., Gilby, N. Dak.
Scott, W. M., Washington, D. C., Bureau of Plant Industry.
Scudder, H. D., Manhattan, Kans.
Searle, Ralph H., Edgar, Nebr.
Severance, Geo., Pullman, Wash.
Shafor, W. A., Hamilton, Ohio, R. R. No. 1.
Shamel, C. A., Chicago, Ill., Orange Judd Co.
Sharp, J. C., Palmyra, Nebr.
Shaw, E. L., Durham, N. H.
Shaw, Guy L., Rockport, Ill.
Shaw, J. A., Perkins, Calif.

Shear, C. L., Washington, D. C., Dept. of Agriculture.
Shelley, W. G., Manhattan, Kans.
Shepperd, Prof. J. H., Agricultural College, N. Dak.
Shoemaker, D. N., Waco, Texas.
Shoesmith, V. M., College Park, Md.
Shuff, Wm. A., Philadelphia, Pa., 4426 Osage Ave.
Shuler, M. R., Clifton, Kans.
Shull, Dr. Geo. H., Cold Spring Harbor, Long Island, N. Y.
Sigerfoos, Chas. P., Minneapolis, Minn., Univ. of Minnesota.
Sil, Surendra Nath., Ithaca, N. Y., 119 Dryden Road.
Simpson, Eugene, Chicago, Ill., 291 Michigan Ave.
Simpson, H. H., Palmer, Ill.
Simpson, Dr. J. C., Palmer, Ill.
Simpson, Q. I., Palmer, Ill.
Simpson, T. L., Palmer, Ill.
Skenandore, Edw. E., Bena, Minn.
Skinner, Prof. J. H., Lafayette, Ind.
Skinner, Robert P., Marseilles, France, American Consulate.
Smith, Archibald, Agricultural College, Miss.
Smith, Frank, Champaign, Ill.
Smith, Fred. E., Los Angeles, Calif., 4110 Main St.
Smith, Prof. H. R., Lincoln, Nebr.,
Smith, Jared G., Honolulu, Hawaii.
Smith, John T., Savoy, Ill. Agricultural College.
Smith, Louie H., Urbana, Ill.
Smith, W. G., Washington, D. C., Bureau of Soils.
Snapp, A. R., Manhattan, Kans.
Snodgrass, M. D., Manhattan, Kans., Expt. Station.
Snyder, F. C., Fremont, Ohio.
Snyder, Penn T., Secane, Pa.
Snyder, W. P., North Platte, Nebr.
Soule, Andrew M., Blacksburg, Va.
Southworth, P. D., Las Cruces, N. Mex.
Spillman, W. J., Washington, D. C., U. S. D. A.
Springer, F. S., Springfield, Ill.
Staley, Joseph P., Sidney, Ohio.
Stanley, Grant, Nisbet, Pa.
Steffens, E. E., Diller, Nebr.
Stevens, F. L., West Raleigh, N. C.
Stockberger, W. W., Washington, D. C., Department of Agriculture.
Stone, A. L., Madison, Wis., Expt. Station.
Stone, L. P., Lincoln, Nebr., 1415 Poplar St.
Storrs Expt. Station, Storrs, Conn.
Strong, J. L., Clarinda, Iowa.
Stuart, William, Burlington, Vt.
Stuehck, R., Roosevelt, Wash.
Summers, H. E., Ames, Iowa.
Suzuki, S., Kuchian Mura, Abuta Gun, Hokkaido, Japan.
Svendsgaard, J., Bowdon, N. Dak.
Swett, Frank T., Martinez, Calif.
Symons, T. B., College Park, Md.

T

Taft, Edw. A., Chicago, Ill.
Taliaferro, W. T. L., College Park, Md.
Taylor, F. W., Durham, N. H.
Taylor, Geo. E., Jr., Shelburne, Mass.
Tefft, J. W., Tully, N. Y.
Temple, R. K., Indianapolis, Ind.
Texas Agricultural & Mechanical College, College Station, Texas.
Thompson, John, Sioux City, Iowa, Farmers' Tribune.
Thompson, O. A., Edgeley, N. Dak.
Thornber, W. S., Pullman, Wash.
Tinker, G. L., New Philadelphia, Ohio.
Toland, J. O., Humboldt, Ill.
Tomhave, W. H., St. Anthony Park, Minn.
Tong Yanghang, Ithaca, N. Y.
Toole, William, Baraboo, Wis.
Tourgee, C. H., Fayetteville, Ark.
Townsend, C. O., Washington, D. C.,
Tracy, S. M., Biloxi, Miss.
Tracy, W. W., Washington, D. C., Department of Agriculture.
Trego, Walter, Hoopeston, Ill.
Tribune, Farmers', Sioux City, Iowa.
Troop, J., Lafayette, Ind.
Trowbridge, E. A., Columbia, Mo., Agricultural College.
Trueman, John M., Champaign, Ill.
Truesdell, Geo., Washington, D. C., Room 22, Wyatt Bldg.

U

Ueland, L. A., Edgeley, N. Dak.
Ullrich, John, Decatur, Ill.
Unitt, P., Seward, Nebr.

V

Vasey, Dowsland, Liberty, Nebr.
Vaughan, J. L., Roanoke, Va.
Vaughan, R. E., Burlington, Vt.
Veeder, B. G., Cohocton, N. Y.
Vernon, J. J., Agricultural College, N. Mex.

W

Waid, C. W, Wooster, Ohio.
Waldron, L. R., Dickinson, S. Dak.
Walker, Ernest, Fayetteville, Ark.
Walker, J. W., Pittsburg, Pa.
Walker, W. B., Macon, Ga., 518 Walnut St.
Wallace, Prof. Robert, Edinburgh, Scotland, Univ. of Edinburgh.
Walter, M. L., Manhattan, Kans., 1000 Humboldt St.
Warburton, C. W., Department of Agriculture, Washington, D. C.
Ward, W. F., Auburn, Ala.
Warren, G. F., Ithaca, N. Y.
Watrous, C. L., Des Moines, Iowa.
Watson, E. B., Ames, Iowa.
Watson, Joseph E., Marbledale, Conn.
Webb, Wesley, Dover, Del.
Webber, Dr. H. J., Ithaca, N. Y.
Weber, C. H. W., Cincinnati, Ohio, 2146 Central Ave.
Webster Co., McCaull, Minneapolis, Minn.
Werk, Willie, Herman, Minn.
Wesbrook, F. F. Minneapolis, Minn., Univ. of Minn.
Wester, P. J., Miami, Fla.
Westgate, J. M., Washington, D. C., Department of Agriculture.
Westgate, Vernon V., 1025 Knox St., Lincoln, Nebr.
Wetherell, Joseph, Camp Chase, Ohio.
Wheeler, G. C., Manhattan, Kans.
Wheeler, W. A., Mitchell, S. Dak., Dakota Imp. Seed Co.
White, Prof. David S., Columbus, Ohio, Ohio University.
White, Davison, Longview, Ill.
White, G. E., Chicago, Ill., 7 W. 15th Place.
White, H. C., DeWitt, Ga.
White, J. C.. Springfield, Ohio, Farm and Fireside.
White, N. B., Norwood, Mass.
White, T. P., Columbus, Ohio.
Whitman, W. G., Valley, Nebr.
Whitten, J. C., Columbia, Mo.
Whitten, L. M., Punta Gorda, Fla.
Wiancko, Prof. A. T., Lafayette, Ind.
Wiggins, Lewis N., Springfield, Ill.
Wilcox, E. M., Auburn, Ala.
Wilcox, J. F., Council Bluffs, Iowa.
Wilgus, Carl B., Conover, Ohio.
Willets, E. V., La Harpe, Kans.
Williams, C. B., Raleigh, N. C.
Williams, C. G., Wooster, Ohio, Expt. Station.
Williams, J. C., Montclair, N. J.
Willoughby, C. L., Experiment, Ga.
Wilson, A. D., St. Anthony Park, Minn.
Wilson, F. W., Phoenix, Ariz.
Wilson, Jas. F., Winchester, Ill.
Wilson, J. F., Poulan, Ga.
Wilson, J. H., St. Andrews, Scotland.
Wis. Agrl. Expt. Assn., Madison, Wis.
Wise, L. W., Lintner, Ill.
Wisner, Scott, Ft. Collins, Colo., 1102 Rem St.
Wood, E. B., Brundidge, Ala.
Wood, Stubbs & Co., Louisville, Ky.
Wood, W. Righter, Omaha, Nebr., "Anwood" R. D. Station "B."
Woodruff, Chas. E., Plattsburg, N. Y.
Woods, Chas. D., Orono, Maine.
Woods, H. E., Crown Point, Ind., R. R. No. 3.
Worthen, E. L., Washington, D. C., Bureau of Soils.
Wright, Jack, Nephi, Utah.
Wyly, J. L., Greenville, Ohio.

Y

Yoder, P. A., Logan, Utah.
Yokahama Nursery Co., Yokahama, Japan, 21-35 Nakamura.

Z

Zavitz, C. A., Guelph, Canada.
Zook, S. B., Lakeport, Calif.

LIFE MEMBERS.

Agricultural Dept., Cape Town, Cape of Good Hope.
Ames, John L., Cole, Tenn.
Bull, C. P., St. Anthony Park, Minn.
Burnham, R. D., Champaign, Ill.
Cananea Cattle Co., Cananea, Sonora, Mexico.
Coker, David R., Hartsville, S. C.
Colorado Expt. Station, Fort Collins, Colo.
Craig, Prof. John, Ithaca, N. Y., 3 East Ave.
Davenport, Dr. C. B., Cold Spring Harbor, Long Island, N. Y.
Davis, Bradley Moore, Woods Hole, Mass.
Dorsett, P. H., Alexandria, Va., 815 S. Patrick St.
Drissen, P. J., Athens, Wis.
Dunwoody, Wm. H., Minneapolis, Minn., Chamber of Commerce.
Ennis, Wm. S., Decatur, Ill.
Erf, Prof. Oscar, Manhattan, Kans.

Fruwirth, C., Hohenheim, Wurttemburg, Germany.
Funk, De Loss, Shirley, Ill.
Funk, Eugene D., Shirley, Ill.
Grout, A. P., Winchester, Ill.
Guthrie, Robert, Superior, Nebr.
Hays, W. M., Washington, D. C.
Henshaw, Samuel, Cambridge, Mass., 8 Fayerweather St.
Hinckley, Thomas, Washington, D. C., 1310 Mass. Ave., N. W.
Hodgkins, Francis I., Lathrop, Calif.
Holbert, A. B., Greely, Iowa.
Horst Co., E. Clemens, San Francisco, Calif., 215-217 Pine St.
Isenburg, Paul R., Hololulu, Hawaii, Box 245.
Kansas Agricultural College, Manhattan, Kans.
Kennedy, Prof. W. J., Ames, Iowa.
Kerrick, Hon. L. H., Bloomington, Ill.
Latham, A. W., Minneapolis, Minn.
Lathrop, Chas. G., Leland Stanford Univ., Calif.
Marquiss, Seymour, Monticello, Ill.
Maryland Agricultural Expt. Station, College Park, Md.
Mickey, O. E., Osceola, Nebr.
Missouri Botanical Gardens, St. Louis, Mo.
Myers, H. F., Alliance, Ohio.
Naples Zoological Station, Naples, Italy.
Ohio State University, Columbus, Ohio.
Oregon Agricultural Experiment Station, Corvallis, Ore.
Osgood, J. C., Redstone, Colo.
Peabody, Hon. Geo. Foster, Lake George, N. Y.
Petrelli, G. J., Boguio, Benguet Province, Philippine Islands.
Pierce, Newton B., Santa Anna, Calif., Pacific Coast Laboratory, U. S. Department of Agriculture.
Polled Durham Breeders' Association, Indianapolis, Ind., Fletcher S. Hines, Sec'y, P. O. Box 445.
Rietbrock, Fred., Milwaukee, Wis., 107 Wisconsin St.
Sconce, H. J., Sidell, Ill.
Schelle, Albert von, Papenvort, Merxplas, Belgium.
Sweet, Lou D., Denver, Colo., 516 Equitable Bldg.
Swenson Bros., Stamford, Texas.
Swift & Co., Chicago, Ill.
TenEyck, A. M., Manhattan, Kans.
Vilmorin, Philippe de, Paris, France.
Ward, Chas. Willis, Queens, N. Y.
Wing, Joseph E., Mechanicsburg, Ohio.

HONORARY MEMBERS.

Burbank, Luther, Santa Rosa, Calif.
Galton, Francis, London, England.

SUBJECT INDEX.

Animal Breeding and Disease 50
Animal Breeding—Report of Committee on Cooperation in 95
Animals—Establishing Type in Breeding 165
Animal Hybridizing—Report of Committee on 184
Animals—Need of Purebred Stocks in the South 268
Animal Selection—Teaching 83
Annual Members 291
Auditing Committee 25-173

Bacon Type—Evolution of 209
Beef Cattle in Ohio—Breeding 21
Bees and Other Insects—Breeding 240
Beets, Sugar—Breeding for Increase of Sugar Content and Yield 102
Breeds, New—Production and Fixation of 34

Cane, Sugar—Improvement of by Selection and Breeding 105
Carnation Seedlings—Heredity in 81
Carnation Breeding 67
Carriage Horses—Report of Committee on Breeding 263
Cattle—Breeding Beef in Ohio 21
Cattle Breeding—What Poultry Breeders Can Learn from 98
Cattelo—Breeding 161
Cereals—Report of Committee on Breeding 122
Chromosome in the Transmission of Hereditary Characters 135
Citrus Fruit Varieties—Improvement of 271
Clover, Red—Some Results in Selecting for Disease Resistance 59
Committee Reports:
- Bees and Other Insects 240
- Carriage Horses 263
- Cereals 122
- Cooperative Work in Animal Breeding 95
- Cooperative Work in Plant Breeding 241
- Corn 154
- Dairy Production 156
- Fiber Crops 270
- Fish 276
- Forage Plants 236
- Forest and Nut Trees 224
- Hybridizing, Animal 184
- Poultry 258
- Sugar Crops 101
- Swine, Breeding 285
- Theoretical Research in Heredity 130
- Tree and Vine Fruits 211
- Vegetables 264

Contents 5
Cooperative Work in Animal Breeding—Committee Report 95
Cooperative Work in Plant Breeding—Committee Report 241
Corn Breeding and Registration 110
Corn—Report of Committee on Breeding 154
Corn, Seed—Methods in Breeding 266
Cotton—Method of Pedigree Breeding Recommended for Improving 213
Cotton Variation—Statistics of 252

Dairy Cattle—Breeding 180
Dairy Production—Report of Committee on Breeding for 156
Directory of Members 291
Disease—Animal Breeding and 50

Education and Breeding 73
Eugenics—Prevention of Degeneration the Only Practical 247

Fiber Crops—Report of the Committee on Breeding 270
Financial Statement 139
Fish—Report of Committee on Breeding 276
Fixation and Production of New Breeds 34
Forage Plants—Report of Committee on Breeding 236
Forest and Nut Trees—Report of Committee on Breeding 224
Forest Trees—Improvement of 227

Grading in Agricultural Judging Contests 260

Heredity—Report of Committee on Theoretical Research in 130
Honorary Members 302
Horses—Breeding 42
Horses, Carriage—Report of Committee on Breeding 263
Horse Hybrids—Report of Committee on Breeding 265
Hybridizing—Report of Committee on Animal 184
Hybridization—Rejuvenation by 76
Hybrids, Horse—Report of Committee on Breeding 265

Insects—Report of Committee on Breeding Bees and Other 240
Introducing New Varieties of Plants 262

Judging Contests—Grading in Agricultural 260

Life Members 301
Litter in Poland-China Sows—Inheritance of Size of 201
Live-Stock Registration—a Plea for More Extended Use of System of 255

Methods in Seed Corn Breeding 266
Mutation Theory—Importance of in Practical Breeding 60

Nut and Forest Trees—Report of Committee on Breeding 224

Oats—Notes on Breeding 280
Officers, 1907 2

Pedigree Breeding of Poultry—Inheritance in 26
Plant Breeding—Report of Committee on Cooperative Work in 241
Plants—Introducing New Varieties of 262
Poland-China Sows—Inheritance of Size of Litter in 201
Potatoes—Results of Hill Selection of Seed 191
Poultry Breeders—What . . . Can Learn From Cattle Breeding 98
Poultry—Inheritance in Pedigree Breeding in 26
Poultry—Report of Committee on Breeding 258
Prefatory Statement 3
Press and Breeding, The 175
Prevention of Degeneration the Only Practical Eugenics 247
Production and Fixation of New Breeds 34
Purebred Stocks of Animals in the South—Need of 268

Registration—Corn Breeding and 110
Registration, Live-Stock—A Plea for a More Extended Use of the System of 255
Rejuvenation by Hybridization 76

Resolutions 173
Response 14
Selection—Teaching Animal 83
Sugar Beets—Breeding for Increase of Sugar Content and Yield..... 102
Sugar Cane—Improvement of by Selection and Breeding..... 105
Sugar Crops—Report of Committee on Breeding..... 101
Swine Breeding—Report of Committee on..... 285

Teaching Animal Selection..... 83
Theory of Breeding—Recent Advances in the..... 132
Theoretical Research in Heredity—Report of Committee on..... 130
Title—Papers Read by..... 208
Tobaccos—Breeding of Kentucky 147
Tobacco Breeding in Ohio 141
Tree and Vine Fruits—Report of Committee on Breeding..... 211
Type, Establishing—In Breeding Animals..... 165

Vegetables—Importance of Description of Varieties..... 199
Vegetables—Report of Committee on Breeding..... 264

Welcome—Addresses of 9-12

AUTHOR INDEX.

Bain, Prof. S. M..... 59
Beach, Prof. S. A..... 211
Boyd, Mossom M..... 255
Briggs, Dr. L. J..... 260
Brown, H. M..... 165

Castle, Dr. W. E..... 34
Chamberlain, Dr. W. I..... 175

Davenport, Dr. C. B.....20-26-132
Dewey, L. H..... 270
Dorner, Fred., Sr..... 67
Dryden, Hon. John..... 209

Emerson, Prof. R. A..... 264
Essary, Prof. S. H..... 59

Funk, Eugene 266
Funk, J. Dwight..... 154

Gaumnitz, Prof. D. A..... 285
Gay, Prof. C. W..... 42
Glover, A. J..... 156

Hays, W. M.....14-73-95
Hine, J. P..... 21
Hopkins, A. D..... 224
Howard, Dr. L. O..... 240

Johnson, R. H..... 98
Jones, C. J..... 161

Klinck, Prof. L. S..... 122

Marshall, Prof. F. R..... 265
Munson, Prof. W. M..... 244

Norton, J. B.....81-280

Plumb, Prof. C. S..... 83

Rice, Prof. James E..... 258
Rommel, Geo. M..... 263

Scovell, Director M. A..... 180
Scherffius, W. H..... 147
Schrenck, Dr. Hermann von... 230
Schroeder, Dr. E. C..... 50
Selby, Prof. A. D..... 141
Shepperd, Prof. J. H..... 236
Shoemaker, D. N..... 252
Shull, George H..... 60
Simpson, Q. I..... 76
Smith, Director C. D..... 101
Smith, Prof. J. Russel..... 227
Spillman, Prof. W. J.....135-184
Sudworth, Geo. B..... 224

Thompson, Dr. W. O..... 9
Titcomb, J. W..... 276
Tracy, J. E. W..... 102
Toumey, J. W..... 230
Townsend, C. O..... 105

Waid, C. W..... 191
Ward, C. W.....130-262
Webber, Dr. H. J..... 213
Wickson, Prof. E. J..... 271
Williams, C. G..... 110
Woodruff, Maj. C. E..... 247
Woods, Dr. A. F..... 241